

IMPLEMENTATION GUIDE
for use with
10 CFR Part 850,
CHRONIC BERYLLIUM DISEASE
PREVENTION PROGRAM



U.S. Department of Energy
Washington, D.C. 20585

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FOREWORD

The Department of Energy (DOE) has established regulatory requirements for the Chronic Beryllium Disease Prevention Program (CBDPP) in Title 10 of the Code of Federal Regulations, Part 850 (10 CFR 850). DOE has developed this Implementation Guide to assist line managers in meeting their responsibilities for implementing the CBDPP. This Guide is approved for use by the Office of Environment, Safety and Health and is available for use by all DOE elements and their contractors. Members of DOE's Beryllium Rule Executive Committee and their support staffs have provided valuable content and practical advice in collaborating in the development of this Guide.

This Implementation Guide is intended to identify acceptable methods for implementing the provisions of 10 CFR 850. It does not establish requirements, but it does restate or cite many of the requirements of 10 CFR 850 and related health and safety Directives. This Guide should be used in conjunction with not only 10 CFR 850 but also DOE's other orders, guides, manuals, and technical standards that have been developed to protect workers' health and safety.

DOE believes that this Guide can serve as an effective tool in meeting the minimum regulatory requirements of 10 CFR 850. It does not contain a comprehensive set of practices and procedures for implementing 10 CFR 850. Rather, it describes methods and techniques that DOE considers acceptable in complying with the regulation. Conformance with this Guide will provide reasonable assurance that the responsible employer has complied with the related regulatory requirements. In many cases, 10 CFR 850 permits DOE elements and contractors to employ other means to achieve compliance as long as they can demonstrate that those measures provide equivalent or better protection for workers.

Both the understanding of chronic beryllium disease and the practices for effectively preventing it continue to evolve at a rapid rate. Therefore, DOE is requesting input for improving the CBDPP and

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this Guide. Beneficial comments (recommendations, additions, and deletions) and any pertinent data that may improve this document should be sent to the Director, DOE Office of Worker Health and Safety (EH-5), U.S. Department of Energy, Washington, D.C. 20585, by letter or by sending DOE's self-addressed Standardization Document Improvement Proposal Form (DOE F 1300.3), available on the web at

<http://www.explorer.doe.gov:1776/pdfs/forms/1300-3.pdf>

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ABIH	American Board of Industrial Hygiene
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
ASME	American Society for Mechanical Engineers
AWE	Atomic Weapons Establishment
BWI	Brush Wellman, Inc.
CAIRS	Computerized Accident/Incident Reporting System
CBD	Chronic Beryllium Disease
CBDPP	Chronic Beryllium Disease Prevention Program
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
D&D	Decontamination and Decommissioning
DOE	Department of Energy
EPA	Environmental Protection Agency
ES&H	Environment, Safety, and Health
FEV	Forced Expiratory Volume
FVC	Forced Vital Capacity
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High-Efficiency Particulate Air
ISM	Integrated Safety Management
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LPT	Lymphocyte Proliferation Test

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MRP	Medical Removal Protection
NIOSH	National Institute for Occupational Safety and Health
NPE	Negative-Pressure Enclosure
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
RCRA	Resource Conservation and Recovery Act
SAR	Safety Analysis Report
SEG	Similar Exposure Group
SOMD	Site Occupational Medical Director
TLV	Threshold Limit Value
TWA	Time-Weighted Average

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1. PURPOSE AND APPLICABILITY

The purpose of this Guide is to provide supplemental information and describe implementation practices to assist responsible employers in effectively developing, managing, and implementing a chronic beryllium disease prevention program (CBDPP) that is consistent with requirements specified in Title 10 of the Code of Federal Regulations, Part 850 (10 CFR 850), Chronic Beryllium Disease Prevention Program. Title 10 CFR 850 is promulgated pursuant to the Department of Energy's (DOE's) authority under section 161 of the Atomic Energy Act of 1954. This Guide supercedes DOE G 440.1-7, *Implementation Guide for use with DOE Notice 440.1, Interim Chronic Beryllium Disease Prevention Program*, dated March 30, 1998.

Specifically, this Guide amplifies the regulatory requirements of 10 CFR 850, provides cross-references to DOE directives and industry consensus standards that contain detailed guidance for implementing specific requirements in 10 CFR 850, and provides explanations, with examples, of DOE's expectations for how to meet the basic requirements for developing and implementing a CBDPP.

Title 10 CFR 850 applies to DOE offices and DOE contractors with responsibility for operations or activities that involve present or past exposure, or the potential for exposure, to beryllium at DOE facilities. It also applies to any current DOE employee, DOE contractor employee, or any other current worker at a DOE facility who is or was exposed or potentially exposed to beryllium at a DOE facility, regardless of which organization currently employs the worker.

Except at the few DOE-operated facilities, DOE federal workers are not usually directly involved in production tasks or other activities in which they would be exposed to airborne beryllium. However, in performing management and oversight duties, DOE federal workers may enter facilities where beryllium is handled. These federal workers who also are potentially exposed to beryllium include DOE workers who work for DOE line programs in the field (e.g., contract oversight personnel), DOE workers who

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work for support programs in the field (e.g., health and safety personnel), and DOE workers who work for DOE line or support programs in headquarters (e.g., health and safety technical experts). Federal agencies are required to ensure the protection of federal workers under the health and safety provisions of 29 CFR Part 1960, *Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters*, as well as Executive Order (EO) 12196, *Occupational Safety and Health Programs for Federal Employees*. DOE's intent in section 850.2(a)(1) is to supplement these general worker protection requirements with specific beryllium-related requirements in the limited instances where DOE federal workers may have the potential for beryllium exposure.

Section 850.2(a)(2) specifies that the rule also applies to DOE contractors with operations or activities involving exposure or the potential for exposure to beryllium. As clarified in the definition of a DOE contractor (section 850.3), DOE's intent is that the contractors covered under this rule include any entity under contract to perform DOE activities at DOE-owned or -leased facilities, including contractors awarded management and operating contracts, integrating contractors, and subcontractors. This section further clarifies that the requirements of the CBDPP apply only to contractors and subcontractors who work in areas or on DOE activities that involve the potential for worker exposure to beryllium.

Title 10 CFR 850 does not apply to former DOE workers, to activities at DOE facilities that do not involve exposures or potential exposures to beryllium, or to activities not conducted at a DOE facility (such as the off-site laundering of beryllium-contaminated protective clothing from a DOE facility). The CBDPP does not apply to beryllium articles or DOE laboratory operations involving beryllium that are subject to the requirements of 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories* (ref. 1). Note that a beryllium article ceases to be an article whenever it is subjected to any activity (machining, forming, firing, lapping, etc.) that could result in the release of beryllium or an exposure to airborne beryllium.

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The Occupational Safety and Health Administration (OSHA) describes laboratory operations for the purposes of 29 CFR 1910.1450 (b) by the following definitions:

- “Laboratory” means a facility where the “laboratory use of hazardous chemicals” occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.
- “Laboratory scale” means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. Laboratory scale excludes those workplaces whose function is to produce commercial quantities of materials.
- “Laboratory use of hazardous chemicals” means handling or use of such chemicals in which all of the following conditions are met:
 - Chemical manipulations are carried out on a “laboratory scale”;
 - Multiple chemical procedures or chemicals are used;
 - The procedures involved are not part of a production process, nor in any way simulate a production process; and
 - “Protective laboratory practices and equipment” are available and in common use to minimize the potential for worker exposure to hazardous chemicals.
- “Protective laboratory practices and equipment” means those laboratory procedures, practices, and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for worker exposure to hazardous chemicals.

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C Furthermore, 29 CFR 1910.1450 does not apply to quality control or quality assurance laboratories, or pilot plants, that support production processes.

The laboratory exemption applies only in instances where relatively small quantities of beryllium are used in a non-production activity. Most of DOE's operations involving beryllium, including operations in DOE's national laboratories, would not be considered laboratory operations by OSHA's definitions and therefore would not be exempt from 10 CFR 850. DOE assumes that its laboratories that are exempt from 10 CFR 850 are complying with 29 CFR 1910.1450 when using small quantities of beryllium.

This Guide is applicable to all DOE activities that are subject to the requirements of 10 CFR 850. The word "must" is used in this Guide to designate requirements from 10 CFR 850. The words "should" and "may" are used to denote optional program recommendations and allowable alternatives, respectively.

This Guide provides DOE's views on acceptable methods of program implementation and is not mandatory. DOE believes that this Guide can serve as an effective tool in meeting the minimum regulatory requirements of 10 CFR 850. Conformance with this Guide will provide reasonable assurance that the responsible employer has complied with the related regulatory requirements. DOE encourages its contractors and organizational elements to go beyond the minimum regulatory requirements and to pursue excellence in their programs. As such, alternate methods that are demonstrated to provide an equivalent or better level of protection are acceptable to DOE.

2. DEFINITIONS

Terms defined in 10 CFR 850 are used in this Guide consistent with their regulatory definitions.

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3. DISCUSSION

Title 10 CFR 850 establishes the requirements for the development and implementation of a chronic beryllium disease prevention program (CBDPP). The objectives of the CBDPP are to reduce the number of DOE Federal and contractor employees currently exposed to beryllium in the course of their work at DOE facilities, minimize the levels of and potential for exposure to beryllium, and establish medical surveillance requirements to ensure early detection that allows for early treatment of the disease.

DOE believes that successful implementation of the CBDPP requires integration into existing worker safety and health programs and initiatives. These include the worker protection program requirements, such as the requirements of DOE O 440.1A, *Worker Protection Management for DOE Federal and Contractor Employees* (ref. 2), and DOE P 450.4, *Safety Management System Policy* (ref. 3). Figure 3.1 shows how this rule integrates with other DOE worker protection requirements and guidance.

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Figure 3.1. DOE Worker Protection Requirements and Guidance

Statutes	Atomic Energy Act of 1954	Energy Reorganization Act of 1974	Department of Energy Organization Act of 1977	Energy Policy Act of 1992
	42 USC Sect. 7274i, Program to Monitor Department of Energy Workers Exposed to Hazardous and Radio-active Substances	Privacy Act of 1974	Freedom of Information Act of 1966	Americans with Disabilities Act of 1990
Regulations	10 CFR 850, Chronic Beryllium Disease Prevention Program	10 CFR 835, Occupational Radiation Protection	10 CFR 602, Epidemiology and Other Health Studies Financial Assistance Program	48 CFR 970, Department of Energy Acquisition Regulations
	10 CFR 830, Nuclear Safety Management	10 CFR 820, Procedural Rules for DOE Nuclear Activities	10 CFR 708, DOE Contractor Employee Protection Program	10 CFR 707, Workplace Substance Abuse Programs at DOE Sites
DOE Requirements Implemented Through Contracts	DOE P 450.4, Safety Management System Policy			
	DOE M 411.1-1A, Safety Management Function, Responsibilities, and Authorities			
	<i>Worker Safety Functions</i>		<i>Nuclear and Other Safety Functions</i>	
	DOE O 440.1A, Worker Protection Management for DOE Federal and Contractor Employees	DOE M 440.1-1, Explosives Safety Manual	DOE O 420.1, Facility Safety	DOE O 420.2, Safety of Accelerator Facilities
	DOE O 442.1, DOE Employee Concerns Program	DOE O 440.2, Aviation	DOE O 425.1A, Startup and Restart of Nuclear Facilities	DOE O 414.1A, Quality Assurance
	DOE O 225.1A, Accident Investigation	DOE O 231.1, Environment, Safety, and Health Reporting	DOE O 460.1A, Packaging and Transportation Safety	DOE-STD-1098-99, Radiological Control

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Implementation Guides	DOE G 440.1-7A, Chronic Beryllium Disease Prevention Program	DOE G 440.1-1, Worker Protection Management	DOE G 421.1-1, DOE Good Practices Guide	
	DOE G 440.1-4, Occupational Medical	DOE G 440.1-3, Exposure Assessment	DOE G.441.1, Series 1 through 13, addresses various aspects of radiation protection program management and administration	
	DOE G 440.1-2, Construction	DOE G 440.1-5, Fire Protection		
	DOE G 440.1-6, Suspect/Counterfeit Items			

To assist responsible employers with the integration objective, Appendix A provides a crosswalk for the guidance provided in this implementation guide to 10 CFR 850 and the directives and guidance contained in DOE O 440.1A and its implementation guides. Additionally, Table 3.1 depicts the relationships between CBDPP requirements and the ISM core functions.

Table 3.1. Relationships Between 10 CFR 850 Requirements and ISM Core Functions

10 CFR 850 Program Requirement	ISM Core Functions				
	Define Scope of Work	Identify Hazards	Establish Controls	Perform Work	Provide Feedback
Baseline beryllium inventory	°	°			
Hazard assessment		°			
Exposure limits			°		
Action level	°		°		
Exposure monitoring			°	°	
Exposure reduction and minimization			°	°	
Regulated areas			°		
Hygiene facilities and practices			°		
Respiratory protection			°		
Protective clothing and equipment			°		
Housekeeping		°	°	°	

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10 CFR 850 Program Requirement	ISM Core Functions				
	Define Scope of Work	Identify Hazards	Establish Controls	Perform Work	Provide Feedback
Release criteria			◦	◦	
Waste disposal			◦	◦	
Beryllium emergencies			◦		
Medical surveillance			◦	◦	◦
Medical removal			◦	◦	
Medical consent			◦	◦	
Training and counseling			◦	◦	
Warning signs and labels			◦		
Recordkeeping and use of information			◦	◦	◦
Performance feedback					◦

All of the CBDPP requirements are mandatory, but the performance-based nature of the rule provides for a graded approach to the development and implementation of many of the program elements.

Figure 3.2 is a flowchart that depicts an example of implementing CBDPP requirements.

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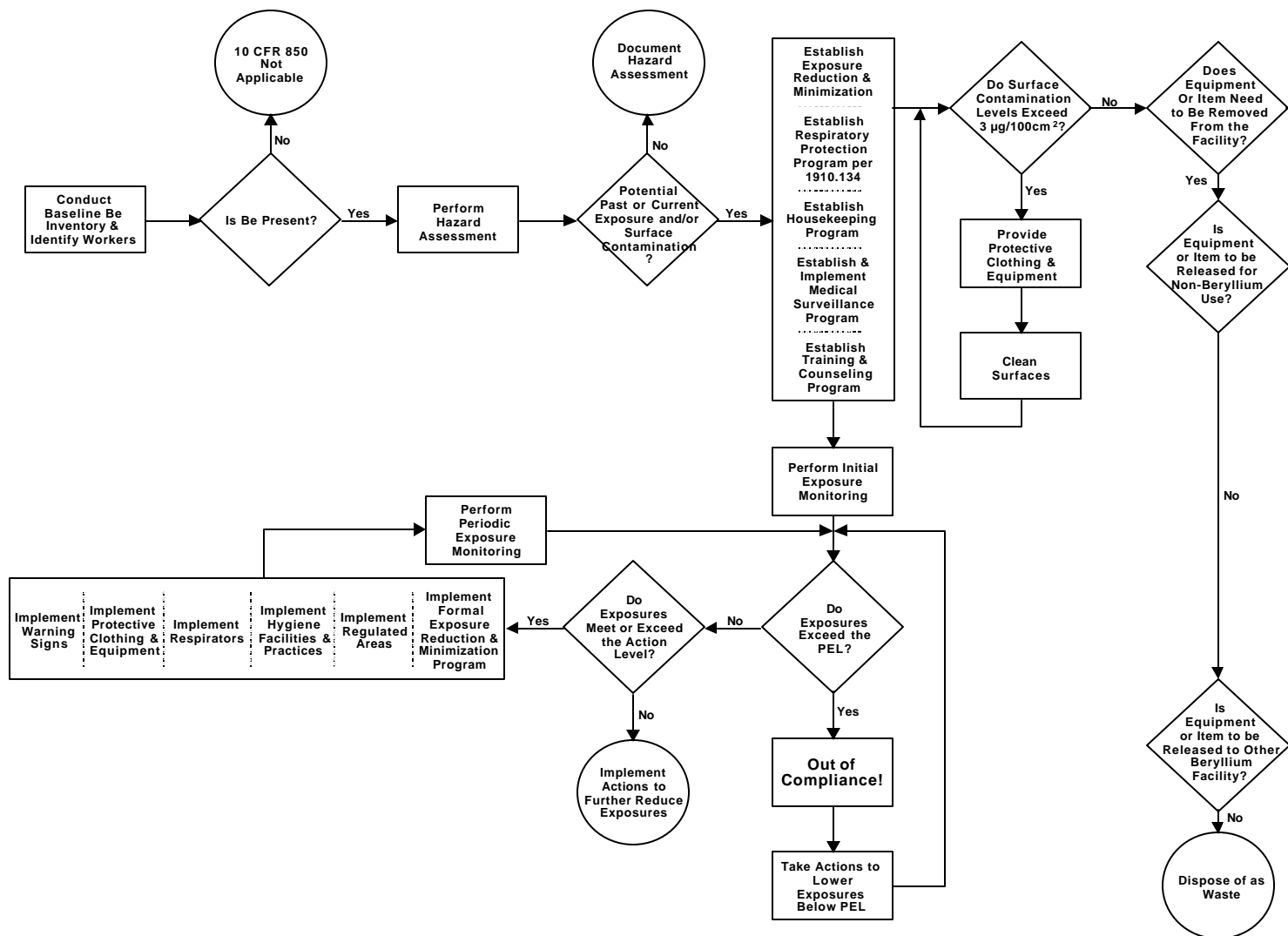


Figure 3.2, Example CBDPP Process

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Title 10 CFR 850 requires that several CBDPP elements be managed by a qualified individual, e.g., a certified industrial hygienist (CIH). The CIH designation is one way to ensure that the manager possesses a sufficient knowledge of industrial hygiene. However, a CIH is not required, and each responsible employer is free to make this determination about qualifications. Responsible employers must have access to competent industrial hygienists for the CBDPP to be successful. Responsible employers should ensure that its industrial hygiene staff:

- C Is adequately trained in the anticipation, recognition, evaluation, and control of hazardous and potentially hazardous occupational exposures, and
- C Has the support necessary to maintain and enhance the staff's proficiency in industrial hygiene through continued training, professional education, and professional activities (e.g., the professional certification process).

Because industrial hygienists have widely varying backgrounds, experience, talent, and education, their development programs should be individualized. Within the worker protection field, opportunities exist for cross-training among the various disciplines. For example, an industrial hygienist may benefit from cross-training in health physics, environmental protection, occupational safety, and waste management, as well as from management training in administration, budgeting, and strategic planning.

The industrial hygiene aspects of the worker protection program should be directed by a senior industrial hygienist with appropriate experience, who should report directly to a senior member of management. A senior industrial hygienist is a person who is certified in the practice of industrial hygiene or who meets the American Board of Industrial Hygiene's (ABIH) requirements for certification. At a minimum, such individuals must have a college or university degree in industrial hygiene or a related scientific, engineering, or technical degree; special studies and training; and 5 years

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of full-time employment in the professional practice of industrial hygiene. An industrial hygiene technician should have, at a minimum, a high school diploma, special studies and training in the field of industrial hygiene, and five years of experience under a senior industrial hygienist. Appropriate introductory-level college courses can serve as the equivalent of one year of experience, and an appropriate associate's degree can serve as the equivalent of two years of experience. [See the ABIH *Bulletin* (ref. 38) for detailed requirements for certification or eligibility for certification.]

DOE G 440.1-4, *Contractor Occupational Medical Program* (ref. 40), describes professional qualifications for medical staff (see Appendix A for relevant citations). In addition, the DOE Department-wide Functional Area Qualification Standard: Industrial Hygiene Qualification Standard may be used to establish the qualifications of industrial hygienists and the Office Specific Standards called for in the Department-wide Technical Qualifications Program may be used to address specific knowledge, skills, and abilities concerning beryllium. That standard can be found at the following web site:

<http://cted.inel.gov/cted/qualstd.html>

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4. IMPLEMENTATION GUIDANCE

The following subsections contain supplemental explanations and examples of the basic requirements for developing and implementing specific elements of the CBDPP.

4.1 Chronic Beryllium Disease Prevention Program

Title 10 CFR 850.10 requires responsible employers to ensure that a CBDPP is prepared and submitted to the appropriate Head of the DOE Field Element before beginning beryllium activities, but no later than 90 days after the effective date of the final rule. A responsible employer is defined as follows:

- Ⓒ For DOE contractor employees, the DOE contractor office that is directly responsible for the safety and health of DOE contractor employees while performing a beryllium activity or other activity at a DOE facility.
- Ⓒ For DOE employees, the DOE office that is directly responsible for the safety and health of DOE Federal employees while performing a beryllium activity or other activity at a DOE facility.
- Ⓒ Any person acting directly or indirectly for such office with respect to terms and conditions of employment of beryllium-associated workers.

The responsible employer may wish to simply revise and refine the CBDPP that was developed in response to DOE N 440.1, *Interim Chronic Beryllium Disease Prevention Program*. If the CBDPP has separate sections addressing the activities of multiple contractors at the facility, the Head of the DOE Field Element will designate a single DOE contractor to review and approve the sections prepared by other contractors, so that a single consolidated CBDPP for the facility is submitted to the Head of the DOE Field Element for review and approval.

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The appropriate Head of the DOE Field Element must review and approve the CBDPP. The initial CBDPP and any updates are deemed approved 90 days after submission if they are not specifically approved or rejected by DOE earlier. The responsible employer must furnish a copy of the approved CBDPP, upon request, to the DOE Assistant Secretary for Environment, Safety and Health or designee, DOE program offices, and affected workers or their designated representatives. The responsible employer must submit an update of the CBDPP to the appropriate Head of the DOE Field Element for review and approval whenever a significant change or significant addition to the CBDPP is made or a change in contractor occurs. The Head of the DOE Field Element must review the CBDPP at least annually and, if necessary, require the responsible employer to update the CBDPP. The responsible employer must submit to the Head of the DOE Field Element for approval only those sections of the CBDPP that have changed.

Due to the wide range of beryllium activities subject to Title 10 CFR 850 and the variety of control methods used to ensure compliance, no specific criteria exist by which DOE can predetermine whether a change to the CBDPP is required. Factors that should be considered include:

- ☐ Mission changes, such as in
 - Amount of beryllium,
 - Processes and work practices,
 - Control systems,
 - Form of beryllium,
 - Number of beryllium-associated workers, and
 - Presence of beryllium in occupied areas;
- ☐ Medical surveillance findings of sensitization and disease;
- ☐ Performance indicators, such as
 - Individual and group exposures,
 - Occurrence trends (ORPS),

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- Medical trends from registry studies,
 - Exposure trends, and
 - Individual occurrences;
- C Administrative considerations, such as
- Worker awareness of conditions and controls,
 - Level of management oversight of routine and nonroutine work activities involving beryllium,
 - Sufficiency of monitoring programs, and
 - Completeness and retrievability of records; and
- C Other factors that would affect full compliance with the CBDPP.

If a responsible employer employs or supervises beryllium-associated workers who are represented for collective bargaining by a labor organization, the responsible employer must give the labor organization timely notice concerning development and implementation of the CBDPP and any revisions. In addition, upon timely request, the responsible employer must bargain with the labor organization concerning implementation of 10 CFR 850, consistent with Federal labor laws. An application of reduction and minimization principles with regard to the protection of workers from the hazards of exposure to beryllium at DOE work sites constitutes a mandatory subject of bargaining under Section 8(a)(5) of the National Labor Relations Act. Where workers are represented for purposes of collective bargaining, in the absence of a waiver of the union's rights, an employer violates that duty to bargain by either (1) unilaterally changing conditions pertaining to workplace exposure to beryllium without notice and bargaining to a good-faith impasse with the collective-bargaining representative of its workers or (2) substantially and materially modifying any collective-bargaining agreement regarding workplace beryllium practices without the agreement of the labor organization.

Title 10 CFR 850.11 establishes requirements for all CBDPPs. DOE's Acquisition Regulation (48 CFR 970) requires DOE contractors to comply with applicable safety and health, public protection,

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and restoration of the environment requirements in Federal rules. Title 10 CFR 850 is an applicable health and safety regulatory requirement and therefore is applicable to DOE contracts and, as such, is not subject to the Work Smart Standards program or similar processes. The CBDPP must specify the existing and planned operational tasks that are within the scope of the CBDPP.

The CBDPP must augment and, to the extent feasible, be integrated into the existing worker protection programs that cover activities at the facility. The detail, scope, and content of the CBDPP must be commensurate with the hazard of the activities performed, but in all cases the CBDPP must include formal plans and measures for maintaining exposures to beryllium at or below the permissible exposure level prescribed in 10 CFR 850.22. In addition, the CBDPP must satisfy each of the specific program requirements of Subpart C of the rule and must contain provisions for:

- C Minimizing the number of workers exposed and potentially exposed to beryllium;
- C Minimizing the number of opportunities for workers to be exposed to beryllium;
- C Minimizing the disability and lost work time of workers due to chronic beryllium disease, beryllium sensitization, and associated medical care; and
- C Setting specific exposure reduction and minimization goals that are appropriate for the beryllium activities covered by the CBDPP to further reduce exposure below the permissible exposure limit prescribed in 10 CFR 850.22.

Table 4.1 below provides specific criteria for inclusion of elements in the CBDPP. As illustrated, certain CBDPP elements must be included regardless of the exposure level. Examples include baseline inventory, hazard assessment, and initial exposure monitoring. Other specific elements of the CBDPP must be included at exposure levels meeting or exceeding the action level. Examples include periodic monitoring, regulated areas, and hygiene facilities and practices. At exposure levels below the action level, less formality is required and sound judgment is essential in considering further reduction and

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minimization efforts. Section 4.2.5 provides more detailed guidance on exposure reduction and minimization.

Table 4.1. Levels at Which the Provisions of the CBDPP Apply

Provision	Worker Exposure or Potential Exposure Levels (8-hr TWA)		
	Be Operations/ Locations ¹	≥ Action Level	> PEL (8-hr TWA)
Baseline Inventory (850.20)	X		
Hazard Assessment (850.21)	X		
Initial Exposure Monitoring (850.24)	X		
Periodic Exposure Monitoring (850.24)		X	
Exposure Reduction and Minimization (850.25)	X ²	X ³	X ⁴
Regulated Areas (850.26)		X	
Hygiene Facilities and Practices (850.27)		X	
Respiratory Protection (850.28)	X ⁵	X	
Protective Clothing and Equipment (850.29)	X ⁶	X	
Housekeeping (850.30)	X ⁷		
Release Criteria (850.31)	X ^{8,9}		
Medical Surveillance (850.34)	X ¹⁰		
Training and Counseling (850.37)	X ¹¹		
Warning Signs (850.38)		X	

¹Applies to beryllium operations and other locations where there is a potential for beryllium contamination.

²Responsible employers must implement actions for reducing and minimizing exposures, if practicable.

³Responsible employers must establish a formal exposure reduction and minimization program, if practicable.

⁴Responsible employers must reduce exposures to or below the PEL.

⁵Responsible employers must provide respirators when requested by the worker.

⁶Responsible employers must provide protective clothing and equipment where surface contamination levels are above 3 µg/100 cm² and when requested by the worker.

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⁷Housekeeping efforts must maintain removable surface contamination at or below 3 µg/100 cm² during non-operational hours.

⁸Removable contamination of equipment surfaces must not exceed 0.2 µg/100 cm² when released to the public or for non-beryllium use.

⁹Removable contamination of equipment surfaces must not exceed 3 µg/100 cm² when released to other beryllium handling facilities.

¹⁰Responsible employers must provide medical surveillance for all beryllium-associated workers who voluntarily participate in the program.

¹¹Training is required for all workers who could be potentially exposed. Counseling is required for beryllium-associated workers diagnosed with CBD or beryllium sensitization.

Title 10 CFR 850.12 requires the responsible employer to manage and control beryllium exposures in all activities consistent with the approved CBDPP Plan. The rule prohibits:

- C Any DOE or DOE contractor employee from taking any action inconsistent with 10 CFR 850, an approved CBDPP, or any other Federal statute or regulation concerning beryllium exposures at DOE facilities.
- C Any task that is outside the scope of the CBDPP involving potential exposure to airborne beryllium from being initiated until an updated CBDPP is approved by the Head of the DOE Field Element. (In the event of an unexpected situation, the Head of the DOE Field Element may approve the task before the CBDPP is updated.)

Title 10 CFR 850 takes a performance-based approach to implementation, and responsible employers are given latitude in choosing the best alternatives for inclusion in their CBDPPs. The rule does not preclude responsible employers from taking any actions they deem necessary to protect the safety and health of workers. Nothing in 10 CFR 850 affects the responsibilities of DOE officials under the Federal Employee Occupational Safety and Health Program (29 CFR 1960) and related DOE directives.

Title 10 CFR 850.13 requires full compliance with the rule no later than 2 years from the effective date of the rule. DOE will enforce CBDPP requirements through contractual remedies, including contract termination or reduction in fee. Title 10 CFR 850.5 permits any adversely affected person to refer a

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dispute regarding compliance with the rule to the Office of Hearings and Appeals for resolution.

Employees who are represented by a labor organization must, however, exhaust any grievance-arbitration procedure that is available for resolving disputes over terms and conditions of employment before filing a petition for relief with the Office of Hearings and Appeals.

4.2 Specific Program Elements

Subpart C of 10 CFR 850 contains 21 sections that constitute the required elements of an acceptable CBDPP.

4.2.1 Baseline Beryllium Inventory

Title 10 CFR 850.20 requires responsible employers to develop a baseline inventory of the locations of beryllium operations and other locations of potential beryllium contamination and identify workers exposed or potentially exposed. The responsible employer must review current and historical records, conduct interviews with workers, conduct beryllium sampling (air, surfaces, and bulk), and document characteristics and locations of beryllium at the facility. In addition, a qualified individual must manage the conduct of the baseline beryllium inventory (see Section 3 for a discussion of “qualified individual”). The responsible employer must ensure that individuals assigned to inventory tasks have sufficient knowledge and experience to perform such tasks properly.

Baseline inventory and sampling are the first steps in determining potential beryllium exposures. The desired outcome is a complete inventory of available information on workers, tasks, materials, and locations that can be reviewed to identify the potential beryllium hazards. The baseline inventory and sampling should provide an inventory of activities that may generate hazardous exposures and a list of the potentially exposed workers, preliminary exposure monitoring data, and preliminary exposure

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profiles of any similarly exposed group of workers that may exist. Included in the inventory is a comprehensive listing of locations where beryllium is located or suspected. This information is vital in determining locations for posting areas, establishing beryllium regulated areas, in conducting work planning, and in establishing standard operating procedures that results in adequate and appropriate worker protection from beryllium hazards.

4.2.1.1 Records Review

The responsible employer should conduct the records review before performing characterization activities (i.e., sampling). This is the first step in developing a baseline inventory and is particularly important for inactive and abandoned facilities that have not recently operated.

The responsible employer should identify all sources of available information about the current and former presence and use of beryllium on-site. At a minimum, this includes collection of the following information sources to the extent they are relevant and available:

- C Rosters of past and present workers in facilities with known usage of beryllium,
- C Procurement documents,
- C Occurrence Reporting and Processing System (ORPS) reports and Computerized Accident/Incident Reporting System (CAIRS) reports,
- C Inventory records,
- C Process flow diagrams,
- C Site maps,
- C Exposure monitoring data,
- C Existing hazard analysis documentation,
- C Safety Analysis Reports (SARs),
- C Reports of health studies,

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- C Standard operating procedures,
- C Facility operating manuals,
- C OSHA 200 logs, and
- C Office correspondence.

The responsible employer should review these records with the objective of identifying the locations or potential locations of beryllium, the form and quantity of beryllium materials or contamination, and facility areas where there is a potential for beryllium exposures or contamination. Many of these records may no longer be available at some DOE facilities (e.g., facilities that have been shut down or abandoned), but may be available at DOE Headquarters offices and Federal and other records collection centers. The responsible employer should clearly document any gaps in beryllium-related information, so that employee interviews and sampling activities can be organized to focus on these areas.

Most DOE facilities have a Records Manager who can assist in locating beryllium-relevant records. Records Managers know what records collections are available and how to access those records. This assistance is especially important for identifying and obtaining historical records that have been placed in archives or records holding areas. Federal agencies are required to group and store records according to categories, referred to as schedules. Two schedules that are likely to contain information on beryllium are the Medicine, Health and Safety schedule and the Material Accountability schedule. Other schedules may also contain information on beryllium since there is considerable variability in how individuals categorize similar records. Some DOE facilities have extensive and well-indexed beryllium-relevant records. Oak Ridge, for example, has made available more than 9000 searchable beryllium-relevant records at the following web site:

http://www.oakridge.doe.gov/Foia/Beryllium_Document_Collection.htm#B

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DOE headquarters Office of Records, Research, Data and Access, EH-64, provides finding and research aids for a wide variety of subjects at the following web site:

<http://tis.eh.doe.gov/workstation/>

In addition, EH-64 maintains an indexed collection of beryllium-relevant records.

4.2.1.2 Employee Interviews

The responsible employer should develop an initial list of employees to interview based on results of the facility records review. Interviews should initially target both current and retired employees who have worked in a facility that housed beryllium operations, and include storage and transportation. This also includes workers who were involved in post-operational activities in which exposure to remaining inventory or residual beryllium was possible (e.g., maintenance workers performing routine surveillance in a shutdown contaminated facility). Workers often know of past beryllium activities for which no records exist.

An initial list of employees may include project managers, engineering support personnel, safety and health staff, and workers. Workers may include employees performing beryllium machining, cutting, heat treating, casting, or welding; decontamination of beryllium-contaminated equipment or facilities; maintenance of beryllium-laden plenums or ventilation ducts; quality assurance of purchased beryllium materials; or other beryllium-related job duty.

The responsible employer should ensure that interviews are well organized and systematically conducted. Results must be documented as beryllium inventory information, consistent with the recordkeeping requirements of the rule (see Section 4.2.19). Also, interviews should attempt to substantiate beryllium-related information gained from records reviews, as well as address missing

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information. At a minimum, the responsible employer should solicit the following data during employee interviews:

- C Information to fill gaps that are evident from records review activities,
- C Undocumented beryllium activities,
- C Undocumented incidents that involved beryllium or that occurred in areas where beryllium was used,
- C Work practices and associated controls used to minimize beryllium exposures, and
- C Facility modifications involving beryllium operations for which as-built drawings do not exist.

4.2.1.3 Sampling and Analysis

The responsible employer must conduct sampling to determine the presence or absence of beryllium materials, surface contamination, or airborne particulates. A sampling and analysis plan may help in organizing and managing the survey. The amount of detail necessary in the plan will depend on the sampling strategy that is to be used and the size and complexity of the area to be covered. At a minimum, the plan should address the following:

- C Where samples are to be taken, based on where beryllium was stored, transported, and used at the facility, as well as consideration of ventilation and airflow patterns and worker movement patterns;
- C How many samples are to be collected, based on the number of potential exposure locations;
- C How the samples will be collected and analyzed, including the air, surface, and bulk sampling methods;
- C Statistical methods that will be used to ensure confidence and representativeness of sample results; and
- C The personal protective equipment (PPE) and procedures that will be used to protect personnel performing sampling activities.

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DOE does not intend that responsible employers sample locations that are not likely to present a reasonable risk of beryllium exposure based on the inventory. The personnel who are conducting the sampling should be knowledgeable of the building structure and function prior to collecting any samples. These personnel should conduct a building “walk-through” to supplement existing process knowledge and other pertinent information gained from facility record reviews and employee interviews. Personnel involved in a building “walk-through” should be adequately protected against beryllium exposures.

The responsible employer should use knowledge gained from the building “walk-through” and other baseline inventory activities to select sampling areas that provide the greatest potential for harboring residual beryllium materials, contamination, or airborne particulates. Table 4.2 provides examples of building areas that may have a high potential for beryllium contamination.

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Table 4.2. Examples of Potential Beryllium Contamination Areas

Building Area	Potential Area of Be Contamination
Floor	Corner of room where dust accumulates
	Traffic area traversed by beryllium workers
	Under an object not routinely cleaned
Ceiling Tile	Adjacent to supply and exhaust ventilation system registers
	Above beryllium processing area
Process Equipment	Still-air areas that accumulate dust
	Hidden surfaces not routinely cleaned
Internal Areas	Back of book shelf
	Under cabinet drawer
HVAC System	Dead areas where dust accumulates
	Top of air ducts
	Access flanges
	Mechanical areas associated with motors and blowers
Miscellaneous Horizontal Surfaces	Door jambs
	Elevated window sills
	Top of light fixtures
	Top of girders or other structural members

Sampling activities should include a sufficient number of samples to ensure at least a 95% statistical confidence level that the results represent the sample population. The American Industrial Hygiene Association's (AIHA's) *A Strategy for Assessing and Managing Occupational Exposure*, second edition (ref. 8), and the National Institute for Occupational Safety and Health (NIOSH) *Occupational Exposure Sampling Strategy Manual* (ref. 4) are good references to obtain techniques for applying statistical principles to sampling.

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The baseline inventory must include surface, air, and bulk sampling. Sections 4.2.4, “Exposure Monitoring,” and 4.2.10, “Housekeeping,” address analytical methods for routine sampling and analysis of these media. These methods also should be applied to the baseline inventory.

4.2.1.4 Baseline Inventory Documentation

The responsible employer must document results of the baseline inventory, so it can be used to support other CBDPP activities. This includes, at a minimum, the following elements:

- C Historical data on the locations where beryllium was processed, stored, or otherwise present;
- C A list of areas where beryllium is currently used or stored, and where beryllium was confirmed not to be present;
- C A list of areas where beryllium surface or air contamination was found to exist; and
- C The quantity and characteristics (chemical form, physical form, and morphology) of the beryllium found.

4.2.2 Hazard Assessment

Title 10 CFR 850.21(a) requires responsible employers to conduct a beryllium hazard assessment if the baseline inventory establishes the presence of beryllium in an area. This requirement allows each responsible employer the flexibility to determine the appropriate risk-based approach for assessing beryllium-related hazards. Since the CBDPP is designed specifically to prevent chronic beryllium disease in workers, the hazard assessment is the mechanism for determining and documenting the potential exposure of workers to airborne beryllium. The hazard assessment must include analysis of existing conditions, exposure data, medical surveillance trends, and the exposure potential of planned activities. Responsible employers should exercise caution in relating previously existing sampling data to current operations and activities because working conditions affecting potential beryllium exposure may

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have changed. Responsible employers must prioritize exposure determinants and characteristics, as well as the exposure potential of activities, so that they can evaluate activities with the greatest risks of exposure first.

4.2.2.1 Beryllium Hazard Considerations

The degree of hazard is a function of the differing toxicity of the various forms of beryllium and of the type and magnitude of beryllium exposure. The chemical and physical form, and morphology, of beryllium are important in determining its toxicity. Researchers posit that beryllium oxide may be the primary chemical form of beryllium that causes chronic beryllium disease. Particles that are initially generated as metallic beryllium develop a coating of beryllium oxide because small beryllium metal particles readily oxidize in ambient air. Respirable-size beryllium metal particles have an exterior coating of beryllium oxide that makes up 25 to 30 percent of the particle by weight. Beryl and other ores contain beryllium silicate, and mining and milling of these materials has not been associated with disease.

The physical size of the beryllium particle most likely is a key determinant of toxicity because it determines whether the beryllium particle will deposit in the lung. Chronic beryllium disease is caused by respirable beryllium particles deposited in the lung. However, the CBDPP action level and PEL, as well as American Conference of Governmental Industrial Hygienist's (ACGIH's) Threshold Limit Values (TLVs) and other exposure limits for beryllium, are based on total airborne beryllium particles. Exposure limits for beryllium historically have been near the detection limits of sampling and analytical methods so that monitoring only the respirable fraction has not been practical. Investigations are underway regarding whether exposure to respirable beryllium particles is a better indicator of risk than is exposure to total beryllium particles. Responsible employers should, where practicable, characterize the particle size distribution of beryllium particles to which workers are exposed as part of the beryllium

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hazard assessment. Exposure to the respirable fraction of, rather than total, beryllium particles may prove to better correlate with medical surveillance results and may be the basis for future standards. The ACGIH's TLV booklet (ref. 5), Appendix D, "Particulate Size-Selective Sampling Criteria for Airborne Particulate Matter," provides additional discussion of the rationale and an approach for size-selective exposure monitoring.

Other determinants of health hazard, in addition to the chemical and physical form, and morphology, of the beryllium, are the likelihood that the beryllium will become airborne and the frequency and magnitude of exposure.

4.2.2.2 Performing Beryllium Hazard Assessments

Title 10 CFR 850.21(b) requires responsible employers to ensure that the hazard assessment is managed by a qualified individual (see Section 3 for a discussion of "qualified individual") and performed by individuals with sufficient knowledge and experience to perform the hazard assessment properly. The responsible employer should consider using a multi-disciplinary team to perform the beryllium hazard assessment. Actual composition of the team will vary depending on the beryllium hazards present and the specific beryllium activity being assessed, but should include:

- C Personnel who are knowledgeable of the facility's support systems (e.g., mechanical, electrical, and physical security);
- C Operations personnel who are knowledgeable of the facility's activities;
- C Environment, safety, and health (ES&H) professionals (e.g., occupational safety, fire protection, emergency management) who are technically qualified to perform hazard assessments and are familiar with the hazards of beryllium work; and
- C Workers who are familiar with the facility and are experienced in beryllium activities.

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Clear roles and responsibilities, authorities, and a chain of command should be established and communicated to each team member.

The responsible employer should ensure that the hazard assessment for each beryllium activity takes into account:

- C The quantities (actual and potential), chemical and physical forms, and morphology of the beryllium;
- C The location of the beryllium;
- C The types of events that can lead to beryllium exposures and contamination, including normal activities and potential beryllium emergencies;
- C The potential for worker exposure and surface contamination;
- C The population of workers that potentially can be exposed and areas that potentially can be contaminated; and
- C The anticipated potential levels of exposure and surface contamination resulting from both normal activities and potential beryllium emergencies.

Responsible employers should also consider other routes of exposure that might not be measured by a breathing zone sample. For example, a worker with beryllium contamination on his or her sleeve could brush the sleeve against his or her nose, resulting in an inhaled dose that would not be captured in a breathing zone sample.

Hazard assessments should also meet the requirements, such as those in DOE O 440.1A, paragraph 4(i), and should be integrated with work planning activities to ensure that controls for the potential exposures of planned work tasks (e.g., maintenance, repair, equipment modifications) are addressed in the specific work plans for those tasks.

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Title 10 CFR 850.30, in addressing surface contamination, only addresses removable surface contamination and surface wipes will not detect beryllium that is difficult to remove, sealed beneath paint, or imbedded in building materials. Such beryllium that is not detectable by surface wipes could potentially become airborne during D&D or remodeling operations. Methods suitable for difficult-to-remove beryllium should be used in addition to surface wipes when identifying potential beryllium hazards for operations that will involve demolition, resurfacing, remodeling, or other procedures that will significantly disturb structures or building materials. Section 4.2.1 provides guidance on using other sources of information (such as worker interviews and records reviews) to identify locations where beryllium may be present on surfaces from prior beryllium activities.

Hazard assessments should include a method of identifying and prioritizing beryllium activities with the greatest exposure risk. An example of a simple method for ranking the hazards of beryllium activities based on potential beryllium airborne concentrations is presented in Tables 4.3 and 4.4.

Table 4.3. Hazard Rankings for Known Airborne Beryllium Concentrations

Airborne Be Concentration	< 0.01 $\mu\text{g}/\text{m}^3$	0.01 $\mu\text{g}/\text{m}^3$ to 0.2 $\mu\text{g}/\text{m}^3$	0.2 $\mu\text{g}/\text{m}^3$ to 2.0 $\mu\text{g}/\text{m}^3$	> 2.0 $\mu\text{g}/\text{m}^3$
Level of Hazard	0	1	2	3

Note: Action level is 0.2 $\mu\text{g}/\text{m}^3$. All levels are 8-hour time-weighted average (TWA).

The responsible employer in this example must identify and prioritize activities based on the potential for generation of dust that contains beryllium. This example is useful in anticipating the levels of airborne beryllium that may be created and may need to be controlled for activities, such as equipment decontamination. Table 4.3 presents an example of ranking the level of hazard of different levels of

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airborne beryllium, and Table 4.4 presents an example of ranking of facility areas based on the magnitude of dust generation.

Table 4.4. Hazard Ranking Based on Magnitude of Dust Generation

Cleanliness of the Area	Level of Hazard		
	Low Dust Generation	Moderate Dust Generation	High Dust Generation
Assumed Clean	0	0	1
Probably Clean	0	1	2
Possibly Contaminated	1	2	3
Probably Contaminated	2	3	3

Note: The hazard ranking is based on the anticipated level of contamination in buildings. The anticipated level of contamination should be based on the process knowledge review of each building, facility, or area. The cleanliness categories are defined as follows:

- C Assumed Clean: Areas where beryllium processing was never conducted, air spaces and ventilation systems are not shared with rooms used for beryllium processing, beryllium workers did not visit unless fully decontaminated, and no other routes of contamination are known.
- C Probably Clean: Areas where beryllium processing was never conducted, but the possibility for cross-contamination from beryllium areas exists through shared air spaces, shared ventilation systems, and cross-contamination by beryllium workers.
- C Possibly Contaminated: Areas that appear to have a direct connection to a beryllium processing area or where small quantities of beryllium were handled.
- C Probably Contaminated: Areas where beryllium processing was conducted and the probability for contamination is considered high.

Limited dust generation is expected in situations similar to office work or walking through an area.

Moderate dust generation is expected in situations similar to manual work or moving furniture. High dust generation is expected in situations similar to decontamination and decommissioning (D&D) work, machining, aggressive cleaning, or dismantling equipment. For example, if the area is assumed to be clean before D&D operations begin and the initial activity will be moving furniture, the preliminary hazard ranking would be zero, or an expected exposure of less than $0.01 \mu\text{g}/\text{m}^3$. However, if the area is assumed to be probably contaminated and most equipment therein will be dismantled, then the

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preliminary hazard ranking is 3, or an expected exposure of greater than $2.0 \mu\text{g}/\text{m}^3$. As the actual operations begin, air samples must be taken and analyzed, and the hazard rankings should be adjusted according to the results.

4.2.3 Exposure Limit and Action Level

The responsible employer must ensure that no worker is exposed to an airborne concentration of beryllium greater than the Permissible Exposure Limit (PEL) that OSHA established in 29 CFR 1910.1000, Subpart Z, *Toxic and Hazardous Substances*, Table Z-2 (ref. 6). OSHA's current PEL is $2.0 \mu\text{g}/\text{m}^3$ as an 8-hour time-weighted average (TWA). Title 10 CFR 850.22 will automatically adopt any new PEL that OSHA sets. The exposure is to be measured by a personal monitor in the worker's breathing zone which is defined as "a hemisphere forward of the shoulders, centered on the mouth and nose, with a radius of 6 to 9 inches." The TWA is the worker's average airborne exposure in any 8-hour work shift of a 40-hour work week.

Title 10 CFR 850.23 sets an action level of $0.2 \mu\text{g}/\text{m}^3$ as an 8-hour TWA as measured in the breathing zone of the worker by personal monitoring. See Table 4.1 for provisions of the CBDPP that are required at the PEL and the action level.

4.2.4 Exposure Monitoring

Title 10 CFR 850.24 establishes requirements for initial monitoring to characterize potential exposures and requirements for periodic exposure monitoring for workers in areas where airborne concentrations of beryllium are at or above the action level. Exposure monitoring is important for determining the levels of beryllium to which workers are exposed, the continuing effectiveness of exposure controls, and whether other controls and worker protections need to be implemented.

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Only airborne concentrations in the breathing zone are considered for purposes of exposure monitoring. Surface sampling is not appropriate for estimating exposures but is useful for evaluating process control and cleanliness, and for determining suitability for release of equipment (see Sections 4.2.10 and 4.2.11). Title 10 CFR 850.24 does not address area air monitoring because area air monitoring results can not be used to represent personal exposure. Area air monitoring may be useful in conjunction with personal air monitoring when characterizing potential worker exposures and when evaluating the effectiveness of process controls. When used for this purpose, area monitors should be placed along the expected path of the exposure where the beryllium concentration is expected to be equal to or greater than the worker's potential exposure. Responsible employers should keep in mind the difficulty of anticipating the actual path of exposure when interpreting area air monitoring results. Area air monitoring may provide information about the source of potential exposures, and it may give additional data about variations in exposure over the course of the work shift.

Breathing zone samples should not be reported as adjusted by protection factors for samples taken while the worker was using respiratory protection. This is the same approach that OSHA uses to demonstrate compliance with OSHA regulations. It permits worker protection professionals to compare and consolidate different sets of breathing zone results. The type of respiratory protection and its protection factor should be noted with the sample results.

Several sources are available for assistance in developing an exposure monitoring strategy (see refs. 7 and 8). Links to additional sources and examples of monitoring strategies and procedures are included on the web page for the Chronic Beryllium Disease Prevention Program Implementation Tool Kit at:

<http://tis.eh.doe.gov/be/itk.html-ssi>

One common element among the referenced material is the development of a beryllium exposure assessment plan. The exposure assessment plan answers such questions as:

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- C Which employees will be sampled?
- C Where will the sampling device be located?
- C How many samples will be collected each shift?
- C How long will the sampling interval be?
- C How many periods during the day should be sampled?
- C How many workdays during the year will be sampled?

Such an assessment plan is an important piece of the overall CBDPP, and it is helpful in:

- C Identifying all potential beryllium exposures;
- C Ranking exposure hazard potential;
- C Identifying potentially exposed workers;
- C Monitoring to characterize exposures;
- C Documenting, communicating, and keeping records of monitoring results;
- C Determining the frequency of monitoring; and
- C Establishing mechanisms to initiate additional monitoring following changes in processes, production levels, materials, controls, work practices, or personnel.

The exposure assessment plan should contain an exposure matrix for all beryllium activities and different forms of beryllium at the facility. Such a matrix is a useful tool for communicating the ranking of exposure potential. Non-routine operations such as maintenance, repair, cleaning, and D&D have some of the highest potential exposures to beryllium.

An effective exposure assessment plan uses statistical principles to determine the most meaningful monitoring regimen and the most meaningful presentation of monitoring results. Results should be presented using statistical tools that also describe the uncertainty, variability, and level of confidence of the results. Two good references for applying statistical principles to the monitoring of beryllium are:

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- C NIOSH Sampling Strategy Manual (ref. 4), and
- C AIHA's *A Strategy for Assessing and Managing Occupational Exposures* (ref. 8).

At the Rocky Flats site, the Beryllium Exposure Assessment Plan includes the following:

- C Baseline characterization and inventory for affected work areas;
- C Hazard assessment and risk ranking documentation;
- C List of employees or job classifications potentially exposed to beryllium during work activities;
- C Exposure assessment strategy for characterizing the potential for exposure, including the type of monitoring, the number of workers to be monitored, the frequency and duration of monitoring, and the supporting rationale;
- C Additional monitoring considerations to address changes in processes, controls, work practices, personnel, and upset or emergency conditions;
- C Communication of exposure monitoring results to workers and management;
- C Documentation and recordkeeping requirements; and
- C Description of sampling and analytical methods.

More details about the Rocky Flats approach and an example of a beryllium risk assessment matrix can be found in the CBDPP Plan document that was prepared in response to DOE Notice 440.1. That CBDPP document can be found on the following web site:

<http://tis.eh.doe.gov/be/Tools.html>

A general requirement of 10 CFR 850.24(a) is that exposure monitoring be managed by a qualified individual [e.g., a Certified Industrial Hygienist (CIH)] and performed by individuals with sufficient industrial hygiene knowledge and experience.

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4.2.4.1 Initial Monitoring

Title 10 CFR 850.24(b) requires the responsible employer to perform initial monitoring for all areas that may have airborne beryllium, as indicated by the baseline inventory and hazard assessment. These initial exposure data are necessary for determining compliance with the PEL, exposure level status with respect to the action level, and to what extent many of the provisions of 10 CFR 850 must and should be implemented. The qualified individual who manages the exposure monitoring, under DOE's performance-based approach, may determine the best monitoring strategy for a particular facility or operation; however, the strategy must be statistically based and must provide enough samples to adequately characterize exposures.

Many responsible employers throughout DOE have already conducted initial monitoring as part of their implementation of the CBDPP required by DOE Notice 440.1. Therefore, responsible employers can use initial monitoring data collected within 12 months prior to the effective date of 10 CFR 850 to satisfy the initial monitoring requirement. Such previous results would only be valid, however, if work conditions have not changed.

The details of the initial exposure monitoring approach are left to the discretion of the responsible employer and the qualified individual who manages the exposure monitoring. An acceptable approach would include the following:

- C All operations and job tasks should be characterized for both full shift and potential peak exposures.
- C New operations, or those recently modified or previously uncharacterized, will likely require the most intensive initial exposure evaluation.
- C Personal monitoring and sample analysis should be conducted in accordance with procedures in the OSHA Technical Manual (ref. 9) and NIOSH methods 7102 and 7300 (refs. 10 and 11) or

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equivalent. Responsible employers should document the equivalency of the equivalent method used.

- C Initial monitoring should include short-term breathing zone samples for operations where it reasonably can be expected that brief, high concentrations of beryllium may be possible. Such samples should be taken during periods that are expected to produce the highest exposure levels.

4.2.4.2 Periodic and Additional Monitoring

Title 10 CFR 850.24(c) requires periodic exposure monitoring of workers who work in areas where airborne beryllium concentrations are at or above the action level ($0.2 \mu\text{g}/\text{m}^3$). The monitoring must be conducted in a manner and at a frequency necessary to represent workers' exposure. In addition, this periodic exposure monitoring must be performed at least quarterly (every three months). These requirements leave plenty of flexibility for responsible employers to determine the monitoring frequency that is best suited for accurately characterizing workers' exposures. Responsible employers should take a risk-based (graded) approach to determining the frequency of monitoring in accordance with the baseline and subsequent hazard assessments. The minimum frequency of 3 months is required because slight process or procedural changes may go unnoticed over time and because facility and equipment deterioration can affect exposure levels. Responsible employers must also perform additional monitoring, and should update exposure assessment plans, whenever operations, maintenance, or procedures change and whenever they have reason to suspect that changes may result in new or additional exposures [10 CFR 850.24(d)]. Exposure assessment plans should be updated annually.

The responsible employer's exposure monitoring plan may specify the use of representative monitoring. If so, then careful planning is needed to ensure that the results are truly representative of all potential exposures. Groups that are characterized by representative monitoring should be selected based on actual tasks performed and their individual exposure histories and not based only on job title. The

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responsible employer should monitor the individuals with the highest expected exposure in a given representative group. The responsible employer can make better decisions about the number of individuals to be monitored as more monitoring is conducted and more operational experience is gained.

DOE G 440.1-3 (ref. 7) contains an in-depth discussion of using similarly exposed groups (SEGs) to represent exposures. An SEG is a group of individuals who perform the same jobs or tasks and who have similar potentials for exposure to hazardous agents (e.g., beryllium). Once an SEG has been established, the responsible employer may monitor the exposures of selected workers in the group to predict the exposures of the remaining workers. A sufficient number of individuals should be monitored to establish a statistically valid exposure profile within the SEG.

The frequency of personal air monitoring should vary with the expected level of beryllium exposure. Statistically-based monitoring is necessary to validate decisions about increasing or reducing the monitoring frequency including terminating monitoring based on inferential parametric statistics. Monitoring frequency may be reduced where repeated, statistically valid, monitoring results demonstrate that exposure levels emanating from processes and controls have stabilized at exposure levels below the action level. Monitoring may be terminated where exposure levels are consistently sufficiently low. However, the responsible employer may conduct monitoring more frequently than the expected level of exposure warrants. An occasional increase in sampling frequency can foster lower exposures by providing meaningful performance measures that motivate workers to actively trend and reduce their own exposures. Responsible employers may better validate their CBDPP through the use of frequent personal monitoring. Additional reasons for frequent personal air monitoring include:

- ③ Greater assurance that workers are not overexposed,
- ③ Better characterization of variable exposures in the workplace,

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- C More effective identification of ways in which individual work practices contribute to high exposures, and
- C More frequent feedback on the efficacy of workplace controls.

The added value of frequent monitoring should be considered when developing an exposure assessment plan. The cost of frequent monitoring can be relatively small compared with that of a worker overexposure or the shutdown of an operation because the gradual degradation of performance of the exposure control system was not noticed.

Exposure monitoring is not required in areas where airborne beryllium concentrations are below the action level, however, monitoring is one of the tools available for exposure reduction and minimization, even at low exposure levels (see Section 4.2.5).

Non-routine operations such as maintenance, repair, cleaning, or D&D operations in the presence of beryllium contamination have a significant potential for exposure to beryllium. Responsible employers should monitor every worker for every shift for non-routine operations, but less monitoring may be appropriate under limited circumstances. Both representative monitoring and reduced frequency of monitoring for specific operations may be appropriate once the operations and their controls are stable and statistically valid monitoring data demonstrate that exposure levels are stable and consistently below the action level. D&D operations tend to be highly variable, so attaining consistently stable D&D operations and controls can be rare. Personal air monitoring must be conducted at least daily for each task or work group to confirm that the level of respiratory protection is adequate wherever respirators are used.

A responsible employer may decide to have workers do a limited amount of self sampling. Having workers “hang their own pumps” can be cost-efficient and can free up industrial hygiene technicians for

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other tasks. However, the qualified individual must take care to ensure that sampling is being properly performed and should not rely on the workers to maintain adequate notes about worksite conditions and potential confounders of the results. Trained technicians still should calibrate the pumps and prepare the sample media. Workers should be adequately trained to operate their own pumps, and the sampling protocol should be reviewed periodically.

Responsible employers performing statistical analysis of personal monitoring data for consistently stable and well-controlled beryllium activities often will find that their exposure data tend to be more variable than typical occupational exposure data. High variability in exposure data normally is associated with lack of control of exposures from an activity, but the opposite is true for these well-controlled activities. DOE's typical responsible employers have been monitoring beryllium exposures at a high frequency and eliminating the predictable exposures. Only the less-predictable exposures remain from these activities, and most of the monitoring data are below the level of detection. These data sets, consisting of large numbers of non-detectable results and a small number of measurable excursions, exhibit a high statistical variability but represent a well-controlled activity. These excursions result from the remaining equipment failures and human errors that can occur even with a well-controlled activity. Responsible employers should recognize that these excursions can present significant health risks due to beryllium's high toxicity and should target such excursions for exposure reduction and minimization efforts.

An acceptable alternative approach to using inferential parametric statistics to describe beryllium exposure profiles would be 100% monitoring for all potentially exposed workers. The Atomic Weapons Establishment (AWE) facility in Cardiff, Wales, monitored every beryllium worker during every shift for the nearly 40 years that they were in operation.

Appendix B contains further guidance on statistical analysis of beryllium monitoring results including examples that use actual beryllium monitoring data obtained at DOE facilities.

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4.2.4.3 Accuracy and Analysis

Title 10 CFR 850.24(e) requires responsible employers to use a method of monitoring and analysis that is accurate to within +25%, with a confidence level of 95%, for airborne concentrations of beryllium at the action level. This degree of accuracy is needed to ensure that exposure monitoring results are sufficiently accurate across the relevant range of exposure levels.

Title 10 CFR 850.24(f) does not specify the sampling and analysis procedures to be used for beryllium analysis. Responsible employers should use NIOSH Analytical Method 7102 (ref. 10), NIOSH Analytical Method 7300 (ref. 11), OSHA Technical Center Analytical Method ID-125G (ref. 35), or equivalent method. For example, an acceptable approach would be that used at Lawrence Livermore National Laboratory (LLNL) for analysis of air samples. LLNL uses a modification of NIOSH Method 7300 for beryllium metal, and an LLNL-developed procedure (employing inductively coupled plasma atomic emission spectroscopy) for high-fired beryllium oxide. The modified NIOSH procedure for beryllium metal uses nitric acid only as the ashing agent (rather than the nitric/perchloric acid mixture recommended in 7300). The LLNL method for high-fired beryllium oxide uses a nitric/sulfuric acid mixture to achieve complete dissolution of the high-fired beryllium oxide. For air samples where only one metal is to be analyzed, sample filters are dissolved to make 10 ml of solution. Samples are dissolved to make 25 ml of solution for air samples where more than one metal is to be analyzed. Any modifications to NIOSH procedures and locally developed analysis techniques must be appropriately validated.

Title 10 CFR 850.24(f) requires responsible employers to have exposure monitoring samples analyzed in a laboratory accredited for metals analysis by the AIHA or by a laboratory that demonstrates quality assurance for metals analysis that is equivalent to AIHA accreditation. Equivalency to AIHA's accreditation means that a laboratory can demonstrate that their testing protocols meet the accreditation

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standards of AIHA. These accuracy and quality requirements are consistent with similar requirements that appear in many of OSHA's expanded health standards for toxic substances.

Responsible employers may use rapid analysis of worker exposure samples as a means of reducing exposures by quickly identifying and controlling unexpected sources. The AWE facility in Cardiff, Wales, successfully used that approach for many years. AWE analyzed samples at the end of each shift, analyzed samples from their most common sources of high exposures during the lunch break at the middle of the shift, and would correct the problems that were identified by unexpected high exposure levels before continuing to operate.

Title 10 CFR 850 has no requirement for particle size sampling, but responsible employers should, where practicable, characterize the particle size distribution of beryllium particles to which workers are being exposed. Section 4.2.2.1 provides the rationale for particle size sampling.

4.2.4.4 Notification of Monitoring Results

Title 10 CFR 850.24(g)(1) requires the responsible employer to notify affected workers of monitoring results in writing within 10 working days after receipt of the results. Employers can notify the workers directly, or they can post the results in a location that is readily accessible to the affected workers but in a manner that does not identify individual workers to other workers. This protection of workers' privacy is consistent with OSHA's substance-specific standards that have posting requirements.

Sampling results should include the actual airborne concentrations of beryllium and the sampling time used for calculation, along with any calculated TWAs. Results provided to the monitored workers should include results both unadjusted and adjusted by respiratory protection factors, along with an explanation of the meaning of the results.

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Title 10 CFR 850.24(g) contains additional requirements for notification when the worker's exposure meets or exceeds the action level. In such cases, the notification to the worker must include:

- C A statement that the action level has been met or exceeded, and
- C A description of the corrective action being taken by the employer to reduce the exposure to below the action level.

In such cases, the responsible employer also must notify DOE and the Site Occupational Medical Director (SOMD) within 10 days of receipt of the results. Notifying the SOMD allows the SOMD to be proactive in refining the medical surveillance protocol for affected workers to ensure effective monitoring and early detection of beryllium-related health effects.

4.2.5 Exposure Reduction and Minimization

The objectives of exposure reduction and minimization must be to reduce the number of workers currently exposed to airborne beryllium in the course of their work at DOE facilities and minimize their potential for, and actual, exposure to airborne beryllium. Title 10 CFR 850.25 uses a graded approach to exposure reduction and minimization based on the level of beryllium hazard. Responsible employers must ensure that exposures are below the PEL; implement a formal program to reduce exposure levels to below the action level, if practicable, and continue to reduce and minimize exposures, if practicable; where exposures are below the action level. Less formality is acceptable for reduction and minimization of exposures that are below, as opposed to above, the action level.

Each responsible employer should consider social, technical, economic, practical, and public policy considerations in developing a rationale for the exposure reduction and minimization that is appropriate for their facilities. Responsible employers must document the rationale in the CBDPP. Each responsible

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employer has broad discretion in selecting control options and should apply a graded approach to minimizing beryllium exposures based on the level of risk of incurring CBD.

4.2.5.1 Graded Exposure Reduction and Minimization Programs

Title 10 CFR 850.25 establishes requirements for reducing and minimizing worker exposures to airborne beryllium. Where exposures are above the action level, section 850.25(b)(1) requires responsible employers to include in their CBDPPs a formal program to reduce exposures to below the action level, if practicable. The program must include:

- C Annual goals for exposure reduction and minimization,
- C A rationale and strategy for meeting the goals,
- C Actions that will be taken to achieve the goals, and
- C A means of tracking progress towards meeting the goals or demonstrating that the goals have been met.

Goals for exposure reduction and minimization should be established and reestablished periodically using a risk-based approach. Reestablishing goals does not require a continuous reduction in exposures, but instead ensures that goals are current with facility missions and the responsible employer is actively engaged in the implementation and continuous improvement of the CBDPP. In some cases, goals may be modified to allow higher exposures consistent with mission changes requiring increased workloads or activities that emit greater amounts of airborne beryllium so long as these goals never exceed the PEL. For sites conducting extensive nonroutine activities, such as D&D, goals reflecting the intrinsically higher level of risk and limited availability of engineering controls may be appropriate. When establishing exposure reduction and minimization goals, the following factors should be considered:

- Existing exposure levels,

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- Reductions in exposures needed to reach the PEL or action level,
- Impact on workers,
- Effectiveness of control options,
- Impact on operations, and
- Social, technical, economic, practical, and public policy considerations in determining the practicability of various control options for reducing and minimizing worker exposure to beryllium.

Section 850.25(b)(2) requires responsible employers to take steps to reduce and minimize exposure to the extent practicable, even if exposures are below the action level. Those steps and the rationale supporting them must be described in the facility's CBDPP. The level of detail and rigor involved in procedures for exposure reduction and minimization may be lower for exposure levels that are below the action level than for exposures that are above the action level.

Responsible employers' goals to achieve exposure reduction and minimization should represent practicable measures. It may be appropriate to establish goals for minimizing exposure levels of groups of workers, minimizing exposure levels of individual workers, and reducing the total number of exposed workers. For example, new facilities offer the opportunity to include cost-effective engineering controls that can achieve goals for minimizing routine exposures to groups of workers. Careful observation of work practices offers the opportunity for achieving goals for minimizing individual exposures. Changing the location of beryllium activities and worker movement patterns offers the opportunity for achieving goals for reducing the number of potentially exposed workers in facilities where modifying the facility is not a viable option.

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Examples of goals reflecting exposure reduction and minimization efforts include:

- No more than (xx) percent of all measured exposures for (xx) time period will exceed the PEL, action level, detection limit.
- Ⓒ There will be (xx) percent reduction of incidents of uncontrolled exposures during (xx) time period.
- The total number of beryllium workers will decrease by (xx) percent during (xx) time period.
- Ⓒ The number of beryllium hazard assessments completed per month will increase by (xx) percent during (xx) time period,
- Ⓒ The number of beryllium-associated workers participating in scheduled medical surveillance per month will increase by (xx) percent during (xx) time period, and
- Ⓒ The number of beryllium-associated workers completing scheduled beryllium hazard communication training per month will increase by (xx) percent during (xx) time period.

Goals should be normalized to reflect mission changes that increase, as well as decrease, the potential for beryllium exposure.

Additional information specific to exposure reduction and minimization goals and performance measures is provided in section 4.2.20. Additional general information on goals can be found in DOE's Training Resources and Data Exchange (TRADE) organization's *How To Measure Performance: A Handbook of Techniques and Tools* (ref. 39).

A multi-disciplinary team, managed by a qualified individual (e.g., an industrial hygienist), should review the beryllium activities, exposure levels, and controls to determine appropriate actions for reducing and minimizing exposures. The team should include line management, workers, maintenance, and worker protection and other support personnel who are familiar with beryllium operations, hazards, and control methods. A typical review may include, but is not limited to, the following:

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- C The general configuration of the facility and impacts of different possible beryllium control strategies on operations including traffic patterns; location of beryllium sources; need for change rooms; number of beryllium-associated workers; decontamination facilities needed; personal monitoring needed; level of training needed; level of physical security needed; adequacy of space for proposed modifications; and the impact on maintenance, production, research, and D&D activities.
- C Verification that the design criteria for beryllium activity operations and controls are consistent with reduction and minimization goals and any applicable regulations or local requirements.
- C Verification that beryllium controls provide the required level of protection from airborne beryllium.
- C Evaluation and confirmation of the adequacy of specific control methods for reducing the opportunity for worker exposures including control of procurement, storage, and transportation of beryllium; local exhaust ventilation systems; and operational area containment systems.
- C Verification that the facility design is able to maintain personnel entry control for each regulated area to prevent the spread of contamination, and that the design is commensurate with the existing or potential beryllium hazard within the regulated area.
- C Assessment of the adequacy of the monitoring planned for activities and spaces that involve potential beryllium exposure to characterize worker exposures and surface contamination, provide measurements needed to implement the reduction and minimization control strategies, and identify elevated or unplanned beryllium exposures.

Work planning efforts should incorporate exposure reduction and minimization strategies to ensure that appropriate control strategies are selected for activities that are managed by work planning systems.

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Fundamental principles of enhanced work planning or a similar collaborative planning process should be followed to ensure that appropriate control strategies are selected for the planned activities. At the completion of short-term beryllium activities such as maintenance, post-job reviews should be conducted to identify lessons learned and best practices to control beryllium exposures during future work. Such reviews are in line with DOE's Integrated Safety Management (ISM) expectations. One of the core functions of ISM is to provide feedback for improvement of work operations.

Links to additional sources and examples of control strategies are included on the web page for the Chronic Beryllium Disease Prevention Program Implementation Tool Kit at:

<http://tis.eh.doe.gov/be/itk.html-ssi>

4.2.5.2 Hierarchy of Controls

Title 10 CFR 850.25(c) mandates using the conventional hierarchy of industrial hygiene controls: material substitution and engineering controls first must be accomplished if practicable, followed by administrative and work practice controls, followed by personal protective equipment. (PPE is addressed in Sections 4.2.8 and 4.2.9 of this Guide.)

Engineering Controls

Primary reliance must be placed on engineering controls for maintaining airborne concentrations as low as practicable. Engineering controls normally include local exhaust ventilation, gloveboxes, and other enclosures. For non-routine operations, temporary enclosures such as glovebags or negative-pressure enclosures (NPEs) can be used to control exposures and contamination. Engineering controls also include wet methods for cutting, grinding, machining, sanding, or processing of solid beryllium. Caution

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still should be exercised since any airborne contaminated liquid that is generated would be a potential source of exposure.

Ventilation

Responsible employers should ensure the proper design, construction, and maintainability of ventilation systems used to control emissions from beryllium activities. Responsible employers should ensure that these ventilation control systems both adequately control the beryllium emissions from the beryllium activity and minimize the exposure potential of those workers who test, service, and repair the system.

Hood configuration and air-flow rates are critical design features for adequate face or capture velocity. Insufficient face velocity and excessive air turbulence allows toxic materials to remain airborne around the hood and potentially to be drawn into the breathing zones of workers. Hood designs should be specific for the actual operation. Exhaust from routine beryllium-processing operations that could produce airborne particulates should be vented to the environment through an approved high-efficiency particulate air (HEPA) filter. Make-up air must be supplied where air is removed from an area. Make-up air systems should be constructed so they do not draw in contaminated exhaust air, do not create turbulence that disperses beryllium contamination, and do not contaminate the workspace with toxic or irritating materials originating from some other location.

The responsible employer should ensure that ventilation control systems for beryllium activities are designed, constructed, and maintained in conformance with a standard such as American National Standards Institute/American Society for Mechanical Engineers (ANSI/ASME) AG-1 (Code on Nuclear Air and Gas Treatment). These systems contain HEPA filters, which should conform to both Section FC of AG-1 (HEPA Filters) and DOE-STD 3020-97 (Specification for HEPA Filters Used by DOE Contractors). Responsible employers should invoke Section 6 (Quality Assurance) and Section 7

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(Packaging, Shipping, and Storage) of DOE-STD 3020-97 if applying only the AG-1 standard, because AG-1 does not cover these subjects.

Responsible employers also may obtain recommendations for design and air-flow specifications of local ventilation systems in the ACGIH *Industrial Ventilation, A Manual for Recommended Practice* (ref. 12). Section 10.40 (Low-Volume/High-Velocity Exhaust Systems) of the ACGIH manual includes applications for beryllium operations. Responsible employers may obtain even better control of airborne beryllium by using state-of-the-art ventilation systems such as the High-Volume/High-Velocity Exhaust System and other systems that Los Alamos National Laboratory (LANL) is using in their new beryllium facility. The LANL system is described in the “Beryllium Technology Facility Auditable Safety Analysis,” which can be found on the web page for the Chronic Beryllium Disease Prevention Program Implementation Tool Kit at:

<http://tis.eh.doe.gov/be/itk.html-ssi>

Engineering controls should also be checked after any change in work operations or equipment that might affect the controls to ensure that changes do not impair or overwhelm the system's efficacy and that all design specifications continue to be met. Normal beryllium operations should not be resumed until the system is shown to be operating properly.

Ventilation systems should be evaluated periodically under actual operating conditions to ensure continued operation at design specifications. For work areas that routinely process beryllium (i.e., at least monthly), visual indicators, audible alarms, telltale power lights, or flow indicators should be installed at appropriate work stations to show that the ventilation is operating properly. Workers should perform operational checks of their engineering controls before beginning work. These are initial tests to ensure that the systems are on and that air is circulating through them. Ventilation systems should be scheduled for preventive maintenance.

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Glove Bags and Negative Pressure Enclosures

Temporary enclosures provide an adequate approach to controlling exposures and contamination for non-routine operations such as maintenance or D&D activities. Responsible employers should use temporary enclosures to keep exposures as low as practicable because exposure levels may be difficult to predict for non-routine activities. Glovebags can provide a flexible, easily installed, and quickly removed temporary work enclosure ideal for small-scale maintenance or D&D activities. Glovebags that are properly installed and used permit workers to remain completely isolated from beryllium dust. Glovebags with support frames can be used as NPEs when connected to a HEPA-filtered vacuum system. Additional information on the use of glovebags can be found in 29 CFR 1926.1101 (ref. 13). That standard is concerned with controlling exposures to asbestos, but much of the information provided is directly applicable to controlling exposures to beryllium dust.

NPEs may be an appropriate control method for preventing contamination outside the enclosure for larger-scale maintenance and D&D activities. This control method does not necessarily reduce exposures of workers within the NPE. Exposures can be minimized within the enclosure, however, by directing air movement away from the workers and toward a HEPA filtration system. NPEs usually are constructed of 6-mil plastic and maintained under a negative pressure of at least 0.02 inch of water pressure differential, relative to outside pressure. Additional information on NPEs can be found in 29 CFR 1926.1101 (ref. 13).

Administrative Controls

Administrative controls can be an effective means for reducing and minimizing worker exposures. The degree of formality and scope of the administrative processes should be commensurate with the beryllium hazards encountered and the complexity of the associated control measures. More rigorous

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administrative processes should be implemented for more complex or hazardous activities.

Administrative processes should include a hierarchy of documents that clearly and unambiguously delineate management policies, requirements, expectations, and objectives for the CBDPP. The documentation should typically include:

- C A policy statement that articulates the responsible employer's commitment to conduct beryllium operations in a manner that will ensure the health and safety of all employees; and
- C Facility-specific procedures that delineate responsibilities and the actions required of managers and workers and that provide detailed instructions for implementing various functional elements of the CBDPP.

Written procedures should be developed and implemented as necessary to ensure compliance with 10 CFR 850, commensurate with the beryllium hazards and consistent with the education, training, and skills of the beryllium workers. Written procedures should be employed under the following circumstances:

- C When worker health and safety are directly affected;
- C When the expected outcome for the process or operations requires that a specific method be followed;
- C When the process or operation is infrequently used and competence training cannot assure adequate implementation; and
- C To document the approved method to implement specific processes or operations.

Administrative controls involve changing work conditions or operations to lower exposure. Examples of appropriate administrative controls include:

- C Scheduling maintenance activities that generate airborne beryllium during times when most workers are elsewhere;

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- C Arranging operations, schedules, or equipment such that fewer persons are potentially exposed or persons are exposed for shorter periods or to lower concentrations of beryllium;
- C Developing location-specific exposure reduction and minimization procedures; and
- C Posting warning signs (see Section 4.2.18).

Administrative control through worker rotation is not recommended because this practice does not reduce the number of workers exposed to beryllium. At the Rocky Flats site, only a limited subset of workers in each trade discipline is used to perform work in beryllium areas. In addition, operations are planned and conducted to be as efficient as possible in order to minimize unnecessary steps and reduce the length of time spent on beryllium operations.

Tours and visitors should not be permitted in areas where there is a potential for beryllium exposure. Instead, alternative methods of viewing the activities and processes, such as closed-circuit television, videotapes, or adjacent viewing rooms with windows, should be used.

Location-specific industrial hygiene procedures are another example of an administrative control for protecting workers from the hazards of beryllium. All beryllium processes and activities that are capable of generating airborne beryllium should have a location-specific industrial hygiene procedure to address the hazards and identify appropriate controls. Examples of such processes are cutting, machining, welding, maintenance, and D&D activities. For non-routine work, a qualified individual (e.g., an industrial hygienist familiar with beryllium controls) should participate in the planning phase and review all work control documents to ensure reduction and minimization goals are addressed.

4.2.6 Regulated Areas

Title 10 CFR 850.26(a) requires responsible employers to establish regulated areas for areas where airborne concentrations of beryllium are measured at or above the action level. Responsible employers

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may establish regulated areas for any location where there is the potential for airborne beryllium at or above the action level or when there is a concern about the potential for spreading beryllium contamination. Regulated areas are established to limit the number of individuals exposed and potentially exposed, to provide formality of operations for persons who enter the location, and to limit the spread of contamination to uncontrolled areas. At the Pantex facility, Beryllium Work Permits have been used for procedure control of all beryllium regulated areas. The permits, signed by the Industrial Hygiene Department, specify work practices, controls, training, and respirators and PPE. At Pantex, visitors are not permitted in beryllium regulated areas unless absolutely necessary; visitors who enter must complete beryllium awareness training, must be escorted, must wear appropriate respirators and PPE, and must comply with procedural requirements.

Title 10 CFR 850.26(b) requires responsible employers to demarcate regulated areas from the rest of the workplace in a manner that adequately alerts workers to the boundaries of the regulated area. This would include the use of physical barriers and signs. Operations and activities with beryllium exposures vary throughout the complex (as well as at an individual facility), so a single type of regulated area would not be appropriate for all possible situations. Regulated areas may vary from a simple barricade around the designated area with a small contamination reduction zone for doffing of contaminated PPE, to a facility where access is gained only through a change room. Asbestos removal procedures should be used (including the use of polyethylene enclosures with three-chamber decontamination units) for operations that could generate visible amounts of beryllium-containing dust. A qualified individual (e.g., an industrial hygienist) should play a major role in determining whether an area needs to be classified as a regulated area, and the type of regulated area should be based on risk of exposure and spread of contamination.

Paragraphs (c) and (d) of 10 CFR 850.26 mandate that responsible employers limit access to regulated areas to authorized persons and keep records of all individuals who enter regulated areas. Responsible

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employers will have to evaluate the affected operation and determine which personnel are necessary for the performance of work and thus are candidates for authorization to enter. Entry records must include the name, date, time in, time out, and work activity. Such a record ensures that employers are knowledgeable about all persons who work in a regulated area and, in addition, serves to relate any health events to possible exposures. Access records are particularly important when exposure monitoring results indicate that an unforeseen elevated exposure has occurred. DOE intends that only individuals who are essential to the performance of work in the regulated area will be authorized entry to the area.

The controls necessary for a regulated area vary to reflect the actual or potential level of airborne concentration or surface contamination. There should be storage outside the area for clean PPE. A contamination reduction zone should be established that has containers for booties, outer garments, respirators, and other equipment. Temporary regulated areas may sometimes be needed for maintenance, intermittent operations, or unforeseen situations. For permanent activities where the action level is likely to be exceeded, regulated areas should be wholly separate rooms maintained at a negative pressure with respect to adjacent areas to minimize the migration of contamination. All potential sources of contamination should be identified to ensure the integrity of the regulated area when moving persons and items out of the area. For example, it may be appropriate to assume that papers inside the regulated area are contaminated. For this reason, the AWE at Cardiff photocopied all papers on a machine at the area barrier. The copies came out of the clean side of the barrier, and the originals were retained in the beryllium area until disposed of as beryllium waste.

4.2.7 Hygiene Facilities and Practices

4.2.7.1 General Practices

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Title 10 CFR 850.27(a) prohibits the use of food, beverages, and tobacco products and the application of cosmetics in areas where exposures are at or above the action level. Responsible employers also may prohibit these items in areas where there is even the potential for airborne beryllium levels at or above the action level. Location-specific procedures should establish acceptable areas for eating, drinking, smoking, and applying cosmetics.

4.2.7.2 Change Rooms or Areas

Title 10 CFR 850.27(b) requires responsible employers to provide clean change rooms or change areas for beryllium workers who work in regulated areas. The change rooms or areas must meet the sanitation requirements of 29 CFR 1910.141. Such facilities are important for decontamination purposes; the proximity of this decontamination facility to the regulated area depends on the beryllium hazards and local conditions. Separate facilities free of beryllium must be provided where beryllium workers can change into and out of personal clothing and protective clothing and where they can store clothing and equipment to prevent cross-contamination. The change room or area must be maintained at negative pressure or located in a way that will prevent the spread of beryllium into the clean room. Responsible employers may use a portion of the regulated area as the change room if circumstances require and if it meets all the criteria in 10 CFR 850.27(b).

4.2.7.3 Showers and Handwashing Facilities

Title 10 CFR 850.27(c) requires responsible employers to provide handwashing and shower facilities for beryllium workers who work in regulated areas. Workers are required to shower when leaving a regulated area at the end of a work shift. The location of the change room and shower and how soon a shower is taken after leaving a regulated area will depend on local conditions. For example, change rooms may not necessarily be located adjacent to regulated areas. It is often impractical to have change

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rooms and showers adjacent to the operations, when the operations are changing, are of short-term duration, or are small scale and low hazard. Conversely, responsible employers should provide a contiguous decontamination facility including showers is for high-hazard operations.

It is important that soiled work clothing be removed in a change room that is separate from the room where street clothing is stored, and that this change room be maintained under negative pressure to all adjacent rooms outside the regulated area. In some cases, soiled overclothes and equipment may be removed in the regulated area, thus combining the change and regulated area if the regulated area meets the requirements of negative pressure with respect to surrounding areas and can be physically separated (e.g., enclosed with a door).

Showers and handwashing facilities must comply with the sanitation requirements of 29 CFR 1910.141.

4.2.7.4 Lunchroom Facilities

Title 10 CFR 850.27(d)(1) establishes requirements to ensure that workers are not exposed to beryllium at or above the action level while eating in lunchroom facilities. The responsible employer must provide lunchroom facilities that are readily accessible to beryllium workers and ensure that the tables for eating are free of beryllium surface contamination. The lunchroom facilities must also meet the sanitation requirements of 29 CFR 1910.141.

Title 10 CFR 850.27(d)(2) prohibits beryllium workers from entering lunchroom facilities with protective equipment or work clothing containing surface beryllium. The surface beryllium must first be removed from clothing and equipment by using a HEPA vacuum (see Section 4.2.10 of this Guide) or some other method that removes the beryllium without dispersing it.

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4.2.8 Respiratory Protection

Title 10 CFR 850.28 establishes the respiratory protection requirements for the CBDPP. Paragraph (a) requires responsible employers to establish a respiratory protection program that complies with OSHA's standard, 29 CFR 1910.134 (ref. 14). Paragraphs (b) through (d) contain supplemental requirements that deal specifically with respiratory protection from airborne beryllium.

The respiratory protection provisions in 10 CFR 850.28 differ in several ways from those in the Notice (DOE N 440.1). This includes requirements for the use of respiratory protection: (1) at the action level rather than at the OSHA PEL, (2) based on task analysis in addition to measured airborne levels, and (3) when requested by beryllium-associated workers, regardless of exposure.

A respiratory protection program is required when the responsible employer has implemented all practical engineering and administrative controls and the action level continues to be exceeded. The responsible employer may also use respiratory protection as part of the exposure reduction and minimization program to further reduce exposures to levels as low as practicable. The responsible employer will find the minimum requirements for a complete respiratory protection program in OSHA's standard, 29 CFR 1910.134 (ref. 14). Responsible employers may elect to use more stringent requirements.

Title 10 CFR 850.28(b) requires responsible employers to provide respirators to all workers who are exposed at or above the action level and all workers who are performing tasks for which analyses indicate the potential for exposures at or above the action level. In addition, the responsible employer must ensure that the respirators are used by these workers. Responsible employers are also required to include in the respiratory protection program any beryllium-associated worker who requests a respirator for protection against airborne beryllium, regardless of measured exposure levels [10 CFR

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850.28(c)]. This includes providing respirators (at no cost) to beryllium-associated workers who request them.

The reason for providing respiratory protection based on task analyses is that many tasks, which normally have no measurable exposure level, may result in high concentrations of airborne beryllium due to a procedure error, worker error, or equipment failure.

Title 10 CFR 850.28(d) requires responsible employers to select respirators that have been approved by NIOSH when NIOSH-approved respirators exist for the DOE task. The responsible employer must select respirators that DOE has accepted under the DOE/LANL Respiratory Protection Acceptance Program when NIOSH-approved respirators do not exist for the particular DOE task.

Additional information on respiratory protection can be obtained from:

- C ANSI standard Z88.2, *Practices for Respiratory Protection* (ref. 15), and
- C AIHA Manual, *Respiratory Protection: A Manual and Guideline* (ref. 16).

ANSI Z88.2 lists assigned protection factors for various respirators. However, on January 8, 1998, OSHA promulgated a revised version of 29 CFR 1910.134. In the revised 29 CFR 1910.134, OSHA reserved Section 29 CFR 1910.134(d)(3)(i)(A) for assignment of protection factors. OSHA's new protection factors will reflect changes in respiratory protection technology and may supercede the factors in the ANSI Z88.2 table. CBDPPs should be updated to reflect these changes once OSHA's new protection factors are published.

The actual protection offered by respirators may vary for individuals depending on the fit of the respirator and the conditions of use. Respirators accepted for use at higher concentrations may be used at lower concentrations. Respirators must not, however, be used at concentrations higher than

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those for which they are approved. Full-facepiece respirators should be worn during operations where airborne soluble forms of beryllium have the potential to cause irritation to the eyes or skin. (Note that 10 CFR 850 does not address soluble forms of beryllium because they do not contribute to the development of chronic beryllium disease. Responsible employers are expected to protect workers from the hazards of soluble beryllium as part of their overall worker protection program, such as the program defined in DOE O 440.1A.)

A good source for additional respiratory protection guidance is the DOE Worker Health and Safety Respiratory Protection located at website:

<http://tis.eh.doe.gov/whs/policy/compliance.html-ssi>

That page provides links to such reference documents as the OSHA Technical Manual, OSHA compliance documents, NIOSH respiratory protection guides, and the Centers for Disease Control and Prevention (CDC) Respiratory Protection Manual.

4.2.9 Protective Clothing and Equipment

Title 10 CFR 850.29 establishes requirements for provision, use, and cleaning of protective clothing and equipment. The use of protective clothing and equipment for beryllium operations must be specified in the CBDPP. [See 29 CFR 1910.132 (ref. 17), 29 CFR 1910.133 (ref. 18), and the OSHA Technical Manual, Section VIII, Chapter 1 (ref. 9).] Responsible employers should provide clean protective clothing and equipment to beryllium workers and ensure its appropriate use and maintenance where dispersable forms of beryllium may contact the worker's skin or eyes. (Note that 10 CFR 850 does not address soluble forms of beryllium because they do not contribute to the development of chronic beryllium disease. Responsible employers are expected to protect workers from the hazards of soluble beryllium as part of their overall worker protection program, such as the program defined in DOE O 440.1A.) Protective clothing and equipment are required when airborne

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concentrations of beryllium are at or above the action level or when surface contamination levels are measured or presumed to be at or above 3 $\mu\text{g}/100\text{ cm}^2$. Responsible employers are also required under 10 CFR 850 (a)(4) to provide protective clothing and equipment to any beryllium-associated workers who request them, regardless of measured exposure levels.

Title 10 CFR 850.29(b) requires responsible employers to comply with the general requirements for PPE in 29 CFR 1910.132. Those general requirements address such topics as training for PPE, proper fit of PPE, and the requirement that PPE be provided at no cost to the worker. The type and variety of protective clothing (e.g., coveralls, lab coats, or shoe covers) should be based on the work conditions and expected contamination levels. Typically, a lab coat, gloves, and booties are the minimum protection needed. Additional protective equipment may also be required, depending on the nature of the operation; this could include face-shields, goggles, coveralls, overalls, jackets, footwear, headwear, and gauntlets.

Responsible employers may choose reusable or disposable clothing. Each choice has its benefits and drawbacks. Reusable clothing is more comfortable to wear but presents the problem of potential exposure of laundry personnel. The type of clothing chosen may also contribute to the potential for heat stress, and the responsible employer should take this into consideration.

Gloves should be worn by workers who may get high levels of contamination on their hands so that the gloves can be removed close to the point of use rather than allowing the hands to spread contamination. (Note that 10 CFR 850 does not address soluble forms of beryllium because they do not contribute to the development of chronic beryllium disease. Responsible employers are expected to protect workers from the hazards of soluble beryllium as part of their overall worker protection program, such as the program defined in DOE O 440.1A.) Open wounds should be sealed because beryllium contamination causes ulcers that can seriously aggravate the wound.

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Title 10 CFR 850.29(c) requires responsible employers to establish procedures for donning, doffing, handling, and storing protective clothing and equipment. Beryllium workers must be prevented from leaving beryllium areas with contamination on their bodies or personal clothing. This includes a requirement that beryllium workers change from their personal clothes into full-body protective clothing and footwear before beginning work in a regulated area. Upon leaving a regulated area, workers should remove protective clothing and discard it as hazardous waste or segregate it with other beryllium-contaminated clothing. Workers should carefully remove and place (not throw) soiled clothing in laundry containers to avoid generating airborne beryllium and unnecessarily contaminating the change room with the beryllium-bearing dust on the clothing. Persons handling soiled clothing should wear high-efficiency respirators, and they should be trained and fit tested with the proper size respirator. Beryllium-contaminated clothing must be appropriately labeled (see Section 4.2.18).

Title 10 CFR 850.29(d) prohibits the removal of beryllium-contaminated protective clothing and equipment from areas that contain beryllium except for laundering, cleaning, maintenance, or disposal. Title 10 CFR 850.29(e) prohibits the removal of beryllium from protective clothing and equipment by means that could disperse beryllium into the air (e.g., blowing or shaking). Responsible employers may use HEPA vacuuming of contaminated protective clothing and equipment as part of the doffing procedure.

Title 10 CFR 850.29(f) gives responsible employers flexibility in determining the frequency for cleaning, laundering, repairing, or disposing of protective clothing based on specific work conditions and the potential for contamination. Beryllium-contaminated clothing and equipment that are removed for laundering, cleaning, maintenance, or disposal must be placed in containers that will prevent the dispersion of beryllium dust. These containers must be appropriately labeled (see Section 4.2.18). Laundry containers should have lids that automatically close behind the deposited clothing. Laundry bags are available that dissolve during the washing process so that laundry workers can avoid the

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potential exposure that could result from opening the bags and handling the contaminated clothing. Plastic laundry bags should not be reused. All used bags slated for disposal must be handled with other beryllium-contaminated wastes and must be properly labeled (see Sections 4.2.12 and 4.2.18).

The responsible employer must notify both on-site laundry workers and off-site contractors who provide laundry services about any beryllium contamination, the hazards associated with the contamination, and appropriate measures to prevent the release of airborne beryllium and to protect laundry workers.

4.2.10 Housekeeping

Title 10 CFR 850.30 establishes housekeeping requirements for operational areas where beryllium is present. Responsible employers are required to conduct routine surface sampling to determine housekeeping conditions wherever beryllium is present in operational areas of DOE facilities, and they must maintain removable surface contamination levels that do not exceed 3 Fg/100cm² during non-operational periods. Removable contamination is defined as “beryllium contamination that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing, or washing.” Surface sampling is not required in non-operational, closed-off rooms or buildings where workers will not be exposed to beryllium contamination. Likewise, sampling is not required in the interior of installed closed systems such as enclosures, glove boxes, or ventilation systems.

Surface monitoring is used to monitor the effectiveness of routine housekeeping and spill-cleanup efforts in a workplace and to help diagnose the sources of beryllium contamination. Monitoring surface contamination levels is an indispensable tool for ensuring that beryllium emissions from operations are under control. The only practical method of monitoring surface levels is to maintain the surface contamination at an established housekeeping level so that elevations above that level can readily be

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detected. Also, the location and pattern of surface levels obtained from surface monitoring results can help to pinpoint any source of airborne beryllium.

Responsible employers must include goals for housekeeping and cleanliness as part of their exposure reduction and minimization efforts (see Section 4.2.5). Responsible employers should minimize accumulations of beryllium dust on surfaces in the workplace. Beryllium contamination on surfaces may become resuspended and contribute to airborne levels if aggressively agitated, however, surface levels should not be used in an attempt to measure worker exposure or assess health risk. Surface sampling results do not correlate with personal exposures or the potential concentration of beryllium particles that are re-entrained into the air.

The appropriate use of surface monitoring should be covered in the beryllium exposure assessment plan (see Section 4.2.4). The frequency of monitoring should be determined using a risk-based approach and can vary from occasional to every shift. Occasional monitoring may be adequate for activities that are not likely to increase surface contamination levels. Examples include activities conducted in administrative areas that are adjacent to, but not within, an active beryllium work area and small-scale tasks that are conducted in ventilated enclosures. Frequent monitoring may be appropriate for activities that have a high potential for increasing surface contamination levels. For example, both the AWE Cardiff facility and the LANL Beryllium Technology Facility perform surface monitoring at the end of every shift.

Responsible employers should use NIOSH method 9100 (ref. 19) for surface monitoring. This method may have to be modified for surfaces smaller than 100 cm² using a procedure such as that described in Appendix D of 10 CFR 835 for radioactive contamination:

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"When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area shall be based on the actual area and the entire surface shall be wiped."

Responsible employers may use surface sampling methods (e.g., dry wipe sampling) other than NIOSH 9100 but should consider transitioning to the NIOSH method (wet wipe sampling) in a cost-effective manner. The Department believes that the use of a single surface sampling method will reduce the variability in results across the DOE complex and allow DOE to determine more easily which control methods work best. Comparability of other methods to the NIOSH method should be documented. DOE recognizes that removable surface contamination may build up during a work shift. Surface sampling should be conducted after normal cleanup at the end of the shift and during non-operational periods rather than during the shift. Additional guidance concerning surface sampling (e.g., recommended number and location of swipe samples) can be found by reviewing sampling plans and procedures in documents in the CBDPP Implementation Tool Kit, which can be found on the web at the following site:

<http://tis.eh.doe.gov/be/itk.html-ssi>

DOE does not wish to preclude the use of surface sampling techniques other than wipe sampling for measuring beryllium contamination. New technologies, such as direct-reading instruments, may provide better results than wipe sampling. New surface sampling technologies should be validated.

Procedures should ensure that housekeeping practices are performed regularly and thoroughly to prevent the accumulation of beryllium-containing dust and to limit the spread of contamination. Housekeeping can, in and of itself, lead to worker exposures to beryllium-contaminated dust. Therefore, procedures should also focus on preventing the spread and re-entrainment of dust during the performance of housekeeping activities.

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Title 10 CFR 850.30(b) requires responsible employers to use wet cleaning methods, vacuuming, or other cleaning methods that avoid the production of airborne dust. The rule cites the use of “sticky tack cloths” as an acceptable cleaning method. Wet cleaning methods are likely to capture and retain beryllium particles before they can be dispersed into the air from dusty surfaces. Acceptable methods of wet cleaning include the use of low-pressure water mists (rather than high-pressure streams that will disperse beryllium particles), power-driven wet scrubber units, wet floor mops, and wet wipes, sponges, and cloths.

Dry cleaning methods are prohibited for cleaning beryllium-contaminated floors and surfaces. Examples of prohibited dry cleaning methods include shoveling, sweeping, or brushing. The use of these methods is acceptable only in completely closed systems such as a glovebox. Another prohibited work practice is the use of compressed air to remove dust containing particles of beryllium unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the disturbed dust.

Title 10 CFR 850.30(c) requires HEPA filters on portable or mobile vacuum units that are used to clean beryllium-contaminated areas. HEPA-type portable vacuum cleaners and dedicated central vacuum systems equipped with HEPA filters are the only types allowed in the cleanup of beryllium. The system used for beryllium also may be used for other toxic contaminants as long as all hazards are considered in the maintenance of the system and disposal of contaminated filters. Title 10 CFR 850.30(d) requires responsible employers to ensure that cleaning equipment used to clean beryllium-contaminated surfaces is labeled, controlled, and not used for nonhazardous materials. DOE's intent with these provisions is to prevent the spread of beryllium-contaminated dust and debris onto workplace surfaces and prevent the release of beryllium-contaminated dust into workplace air since equipment such as vacuum cleaners often are a major source of beryllium-contaminated dust and debris.

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Dedicated central vacuuming systems that discharge outside after filtration will normally be operating under permits from the local authority for enforcement of the Clean Air Act. The filtration system and the maintenance schedule may be specified in the local authority permit.

Periodic maintenance is critical for vacuum systems. Such maintenance should be conducted on both portable and fixed vacuum systems. Maintenance normally includes pressure drop testing to determine when a filter is clogged and needs to be cleaned or replaced, and aerosol penetration testing to determine that no leaks have developed in or around the HEPA filters. Old filters must be properly labeled and handled as beryllium waste. Aerosol penetration testing of HEPA filters is also normally done when a new filter is installed to ensure that the unit is correctly positioned and dust is not leaking around the filter. (See Section 4.2.5.2, “Engineering Controls, Ventilation” for additional guidance on HEPA filters.) Workers doing filter testing and maintenance have the potential for beryllium exposure, and responsible employers must take appropriate steps to protect them and minimize exposure.

The responsible employer should determine if it would be preferable to conduct cleanup where a spill has resulted in beryllium contamination of an item or to isolate and transport the item to another location for decontamination. Reasons to transport the item may include lower risk to workers performing the cleanup or better technology resulting in a more effective cleanup process.

4.2.11 Release Criteria

Title 10 CFR 850.31 requires responsible employers to clean beryllium-contaminated equipment and other items to the lowest contamination level practicable and label such equipment or items before releasing them to the general public or a DOE facility for non-beryllium use, or to another facility for work involving beryllium. The phrase “and other items” covers tools, supplies, documents, etc., but

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does not include real property or buildings. The responsible employer must ensure before releasing equipment or items to the public or releasing them for use in a non-beryllium area that:

- C Removable contamination does not exceed the higher of either 0.2 $\mu\text{g}/100\text{ cm}^2$ or the concentration of beryllium in soil at the point of release;
- C The equipment or item is labeled in accordance with 10 CFR 850.38(b); and
- C The responsible employer has obtained the recipient's commitment to implement controls that will prevent foreseeable beryllium exposure, considering the nature of the equipment or item and its future use and the nature of the beryllium contamination.

The responsible employer must ensure before releasing beryllium-contaminated equipment or items to another facility performing beryllium work that:

- C Removable contamination does not exceed 3 $\mu\text{g}/100\text{ cm}^2$;
- C The equipment or item is labeled in accordance with paragraph 10 CFR 850.38(b); and
- C The equipment or item is enclosed or placed in sealed, impermeable bags or containers to prevent release of beryllium dust during handling and transportation.

Title 10 CFR 850.31 allows responsible employers to confirm that the release criteria of 0.2 $\mu\text{g}/100\text{ cm}^2$ for public or non-beryllium use is not being exceeded on equipment or an item due to the accumulation of dust or dirt consisting of background soil that contains naturally occurring beryllium. Large amounts of dust and dirt may have accumulated on equipment or other items, particularly in old facilities. The responsible employers may analyze the dust or dirt for beryllium. Dust or dirt that contains less than 0.1 percent beryllium does not meet the rule's definition of beryllium. Guidance for conducting surface sampling (e.g., recommended number and location of swipe samples) can be found by reviewing sampling plans and procedures included in the CBDPP Implementation Tool Kit, which can be found on the web at the following site:

<http://tis.eh.doe.gov/be/itk.html-ssi>

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Contamination can typically be removed by vacuuming surface dust using a HEPA vacuum and wet-wiping with water containing a wetting agent or an industrial soap. Another cleaning technique that has been effective involves using “sticky tack cloths”; the dust-containing beryllium readily adheres to the sticky cloth, facilitating cleanup. However, wet-wiping and tacky cloths may not be effective on absorptive materials such as ceiling tiles or upholstered furniture. The responsible employer should use a HEPA vacuum on these items. A thorough discussion of equipment decontamination strategies can be found in DOE’s *Handbook for Occupational Health and Safety During Hazardous Waste Activities* (ref. 20). Decontamination may have to be repeated several times to reduce beryllium levels below the limits established in 10 CFR 850.31, depending on the equipment’s or item’s surface characteristics and the chemical and physical form, morphology, and concentration of the beryllium particles. The responsible employer should verify contamination removal using surface sampling techniques such as NIOSH method 9100 (ref. 19) prior to release of equipment or items.

The responsible employer also must give attention to internally contaminated surfaces of equipment. For example, a lathe or other piece of equipment may be free of removable surface contamination, and therefore releasable, but may contain internal dust that could become airborne and present a health hazard to subsequent users (e.g., during repair activities). Such items must be labeled to warn workers who may disassemble them in the future. Examples of appropriate labels are contained in Section 4.2.18. On the other hand, a different releasable piece of equipment may contain internal beryllium contamination combined with other substances (e.g., grease) which would make it unlikely that the beryllium would ever become airborne. The presence of this type of “non-removable” contamination, even at levels above the removable contamination release criteria, may not necessarily present a health hazard. Accordingly, equipment with internal beryllium dust is a greater potential risk than equipment with internal beryllium dust imbedded in grease and the responsible employer must consider those risks to future users before releasing any equipment or item. Section 4.2.2, “Hazard Assessment,” discusses

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techniques for evaluating risk and should be used to support decision making on release of equipment or other items.

The responsible employer should determine controls or conditions that are necessary to prevent future beryllium exposure and incorporate these as conditions for releasing equipment or other items. For example, this could include a requirement that appropriate safety and health personnel such as industrial hygienists be contacted prior to beginning repairs or maintenance on equipment. Documents transferring ownership of items with actual or potential beryllium contamination should inform the new owner of the contamination, steps taken or not taken to clean both internal and external surfaces, surface contamination levels, hazards associated with beryllium exposure, and appropriate protective measures related to beryllium exposure. The responsible employer should obtain documentation of the recipient's commitment to implement the controls that will prevent foreseeable beryllium exposure.

Title 10 CFR 850.31(c)(3) requires the responsible employer to ensure that a released item is enclosed or placed in sealed, impermeable bags or containers to prevent exposure to beryllium during handling and transportation to its destination. Enclosure can be accomplished by any practical means such as wrapping in plastic. Labeling of equipment is also a requirement prior to release and should be performed in accordance with 10 CFR 850.38(b) (see Section 4.2.18.)

4.2.12 Waste Disposal

Title 10 CFR 850.32(a) requires responsible employers to control the generation of beryllium-containing waste, as well as beryllium-contaminated equipment and other items that are disposed of as waste, through the application of waste minimization principles (see Section 4.2.5). Beryllium-containing waste, as well as beryllium-contaminated equipment and other items that are disposed of as waste, must be disposed of in sealed, impermeable bags, containers, or enclosures to prevent the

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release of beryllium dust during handling and transportation. Labeling of all bags, containers, and enclosures used for disposal of beryllium waste must be in accordance with 10 CFR 850.28 (see Section 4.2.18).

4.2.12.1 Minimizing Beryllium Waste

The goal of waste minimization is to reduce, to the extent practicable, the amount of hazardous waste that is generated or subsequently treated, stored, or disposed. Waste minimization and pollution prevention programs have been mandated for DOE facilities through Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements* (ref. 21), and Executive Order 13101, *Greening the Government Through Waste Prevention, Recycling and Federal Acquisition* (ref. 22). Responsible employers should coordinate with personnel responsible for managing waste minimization programs on their site to develop specific goals for wastes that contain beryllium. At a minimum, the following waste reduction principles should be reviewed and implemented, if appropriate, for beryllium operations:

- ⌚ Source reduction techniques including:
 - Substitution of less toxic materials for beryllium,
 - Process improvements (automation, improved equipment, equipment layout changes, new technology) that reduce the quantities of beryllium required, and
 - Improved operating practices (operating and maintenance procedures, material handling, inventory control) that improve efficiency and reduce the quantities of beryllium required;
- ⌚ Recycling of beryllium materials through re-use or reclamation; and
- ⌚ Improved treatment methods for beryllium waste.

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Appendix B of the Environmental Protection Agency's (EPA's) *Facility Pollution Prevention Guide* (EPA/600/1-92/088) (ref. 23) addresses waste reduction practices for various industries, including fabricated metal and metal casting, and may be consulted for relevance to a facility's beryllium operations.

A waste minimization assessment is a useful tool in identifying opportunities for reducing beryllium wastes. Responsible employers may conduct assessments in accordance with the EPA's *Waste Minimization Opportunity Manual* (EPA/625/7-88/003, July 1988) (ref. 24). An assessment should begin with of a careful review of a facility's operations and beryllium waste streams and selection of specific areas to be assessed. Next, options with potential to minimize beryllium waste should be developed, screened, and evaluated for technical and economic feasibility. Finally, the responsible employer should select and implement the most promising option(s).

4.2.12.2 Beryllium Waste Management

It is possible that beryllium waste or discarded items containing beryllium may be regulated under the Resource Conservation and Recovery Act (RCRA). Generators of solid waste are required by 40 CFR 262.11 to evaluate their wastes at the initial point of generation to determine whether the wastes are hazardous. EPA has established a hierarchy of steps for making this determination. The Office of Environmental Policy and Assistance (EH-41) has prepared a computer-automated tool to assist in performing these evaluation steps. It may be obtained at the following web site: <http://www.eh.doe.gov/oepa> (go to "tools" and select "RCRA Definitions of Solid and Hazardous Waste").

Responsible employers should begin this evaluation with a determination of whether beryllium-contaminated waste is excluded or exempted from regulation. Criteria given in 40 CFR 261.3, 261.4

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(e.g., samples, scrap metals), 260.20, and 260.22 may be used for this determination. For example, 261.3 exempts non-wastewater residues such as slag that result from high-temperature metals recovery processing of certain wastes, when beryllium concentrations are below 0.010 mg/l. If the beryllium waste is not excluded based on evaluation of these criteria, the responsible employer should evaluate whether the waste meets a listing prescribed in Subpart D of Part 261.

Subpart D of 40 CFR Part 261 contains four lists of wastes:

- C Non-specific sources (F-listed wastes) such as spent solvents from degreasing operations,
- C Specific industry sources (K-listed wastes) such as distillation bottoms from the production of nitrobenzene by the nitration of benzene,
- C Commercial chemical products, off-specification species, container residues and spill residues that are considered acute hazardous waste that can cause injury or death with only small exposures (P-listed wastes), and
- C Commercial chemical products, off-specification species, container residues and spill residues that are considered teratogenic, carcinogenic, mutagenic, and/or toxic but are not likely to be immediately dangerous to life (U-listed wastes).

Beryllium powder is specifically identified as a P-listed waste in 40 CFR 261.33. This includes beryllium powder that is discarded or intended for discard, such as residue that remains in a container or in an inner liner removed from a container [see 40 CFR 261.7(b) for criteria to determine exclusions for containers]. Responsible employers should also examine the other lists (e.g., F-list, K-list) within Subpart D to determine their applicability.

If a waste does not meet a listing in Subpart D, the responsible employer should determine whether the waste exhibits one of the four characteristics found in Subpart C of 40 CFR 261. These include ignitability, corrosivity, reactivity, or toxicity. Most beryllium materials are not considered to be

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ignitable, corrosive, or reactive, and therefore these characteristics can generally be eliminated. The toxicity characteristics of Subpart C are determined based on 40 constituents listed in 40 CFR 261.24. Beryllium is not listed as one of the 40 constituents. Nonetheless, responsible employers should still evaluate Subpart C criteria for applicability to wastes that contain beryllium compounds in question.

If it is determined that beryllium-contaminated waste items are regulated as hazardous waste, responsible employers should consult EPA and state regulations for permitting and other restrictions for hazardous waste treatment, storage and disposal. These include 40 CFR 262 through 266, 268 and 270. Environmental personnel who are familiar with applicable regulations should be involved in establishing any necessary permits.

The responsible employer must dispose of beryllium-contaminated waste in such a manner as to minimize airborne exposures both to workers during waste handling and to downstream handlers of the waste. Disposing of beryllium-contaminated items as waste may be more protective of workers, in some cases, than cleaning the item so that it can be reused or recycled rather than disposed of as waste. Worker protection takes precedence over waste minimization but, in most situations, both can be achieved simultaneously.

Beryllium-contaminated materials (including waste, scrap, debris, equipment, and clothing) must be disposed of properly and placed in impermeable enclosures, such as sealed bags or containers, and labeled in accordance with requirements of 10 CFR 850.28. The activities of containment and labeling of beryllium waste are considered beryllium operations and must be included in the CBDPP. RCRA requirements on labeling must be followed when beryllium waste is regulated as a hazardous waste.

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4.2.13 Beryllium Emergencies

Title 10 CFR 850.33 requires responsible employers to comply with 29 CFR 1910.120(l) for beryllium emergencies related to D&D operations and 29 CFR 1910.120(q) (ref. 25) for beryllium emergencies related to all other operations. This requirement avoids duplication of effort while ensuring consistent and coordinated responses to beryllium emergencies at DOE facilities.

Though not stated, responsible employers must comply with requirements of DOE O 151.1, *Comprehensive Emergency Management System* (ref. 26), when this order is invoked in relevant contracts. It is likely that many beryllium operations are located within facilities that have already established an emergency management program in response to DOE O 151.1 requirements.

The responsible employer should be aware that 29 CFR 1910.120 (HAZWOPER) requirements are more restrictive than DOE O 151.1 in some areas, and further actions may be necessary to ensure that beryllium operations are in compliance. For example, HAZWOPER is more restrictive in five emergency response program areas: documentation requirements, emergency response organization, emergency equipment and personal protective equipment, training, and medical surveillance. A discussion of these elements, as well as a good overview of HAZWOPER emergency management requirements, can be found in DOE's *Handbook for Occupational Health and Safety During Hazardous Waste Activities* (ref. 20).

The primary emergency management requirements of 29 CFR 1910.120(l) include:

- C Preparation of a comprehensive emergency response plan as a separate component of the Facility Safety and Health Plan;
- C Compatibility and integration of the plan with disaster, fire, and/or emergency response plans of local, state, and federal agencies;

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- C Periodic rehearsal of the plan as part of the site's training activities;
- C Periodic review and update of the plan;
- C Installation of an employee alarm system; and
- C Implementation of the plan in the event of emergencies.

Emergency management requirements of 29 CFR 1910.120(q) are applicable to any facility where there is a potential for a hazardous substance release, including beryllium. Sites that have implemented a program that is compliant with Section 303 of the Superfund Amendments and Reauthorization Act of 1986 (Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. 11003) are considered to have met the requirements of 29 CFR 1910.120(q). Emergency management elements of paragraph 29 CFR 1910.120(q) require an emergency response plan similar to paragraph (l), as well as the following additional requirements:

- C Emergency response indoctrination briefings to skilled support personnel who may be needed temporarily to perform emergency support work (e.g., mechanized earth moving, crane and hoisting operations);
- C Training and annual demonstration of competency for specialists who work with and are trained in the hazards of specific substances (i.e., beryllium);
- C Training based on the duties and functions of each responder of an emergency response organization (e.g., "first responder awareness" level needs to understand beryllium characteristics and associated risks during an incident);
- C Certification of trainers;
- C Medical surveillance and consultation of emergency response employees;
- C Protective clothing and equipment for emergency response personnel (e.g., respirators); and
- C Post-emergency response operations including removal of materials or contamination from the site of the incident (e.g., decontamination of equipment or items using techniques discussed in Section 4.2.11).

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4.2.14 Medical Surveillance

Title 10 CFR 850.34(a)(1) requires responsible employers to establish and implement a medical surveillance program for beryllium-associated workers who voluntarily participate in the program. The medical surveillance program is intended to achieve several goals: (1) identification of workers at higher risk from the adverse effects of beryllium, (2) prevention of beryllium-induced disease by linking health outcomes to beryllium tasks, and (3) making possible the early treatment of beryllium-induced disease. The requirements in 10 CFR 850.34 address:

- C Implementation of a medical surveillance program administered by the Site Occupational Medical Director (SOMD);
- C Baseline, periodic, and emergency medical evaluations and procedures;
- C Multiple physician review;
- C Alternate physician determination;
- C Information provided to the responsible employer and the beryllium-associated worker;
- C Reporting; and
- C Data analysis.

Records at many facilities identify some workers who are known to have been exposed to beryllium. Incidentally exposed workers in the past, however, often were not considered to be at risk for CBD and were not identified as potentially exposed. Workers should be given an opportunity to self-identify as potentially having been exposed to beryllium in the past since historical records may be incomplete. Projects involving beryllium at some facilities had a limited duration, and some workers may recall that they worked on those projects rather than that they worked with beryllium.

Title 10 CFR 850.34(a)(2) requires the responsible employer to designate an SOMD, who is responsible for administering the medical surveillance program.

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Title 10 CFR 850.34(a)(3) requires responsible employers to ensure that the medical evaluations and procedures required by the rule are performed by, or under the supervision of, a licensed physician who is familiar with the health effects of beryllium. Not all physicians are familiar with the evaluation of beryllium-exposed patients. It is DOE's intent that these medical evaluations and procedures be performed by a pulmonary medicine physician, an occupational medicine physician, or any other physician who has the specialized equipment and examination protocols needed to differentiate between CBD and other lung diseases. Symptoms that may indicate the presence of CBD are listed in a discussion of the disease at the following web site:

<http://tis.eh.doe.gov/be/webdoc1.html-ssi>

Title 10 CFR 850.34(a)(4) requires the responsible employer to establish and maintain a list of beryllium-associated workers who may be eligible for protective measures. The list must be based on the results of the hazard assessment, exposure records, and other information regarding the identity of the beryllium-associated workers. The list must be adjusted at regular intervals based on the results of the periodic medical evaluations of the beryllium-associated workers.

Title 10 CFR 850.34(a)(5) requires the responsible employer to provide the SOMD with the information needed to operate and administer the medical surveillance program. The information includes: a list of beryllium-associated workers who may be eligible for the protective measures of the rule, the baseline inventory, hazard assessment and exposure monitoring data, the identity and nature of activities or operations on the site that are covered under the CBDPP-related duties of beryllium-associated workers, and the type of PPE used by beryllium workers.

Title 10 CFR 850.34(a)(6) requires that the SOMD and the examining physician must also be provided with:

C A copy of 10 CFR 850 and its preamble;

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- C A description of the workers' duties as they pertain to beryllium exposure;
- C Records of individual workers' beryllium exposures; and
- C A description of the personal protective and respiratory protective equipment used by the worker in the past, present, or anticipated future.

Title 10 CFR 850.34(b) requires responsible employers to provide three types of medical evaluations (baseline, periodic, and emergency) to beryllium-associated workers who voluntarily participate in the medical surveillance program. The evaluations must be provided at no cost to the worker and at a time and place that are reasonable and convenient to the worker. Participation in the medical surveillance program is not mandatory for workers. Once a worker is enrolled in the medical surveillance program, however, the worker will remain enrolled for the duration of employment at a DOE facility.

Title 10 CFR 850.34(b)(1) establishes requirements for the baseline medical evaluation. The purpose of the baseline medical evaluation is to: (1) establish the current health status of each worker and determine whether it is appropriate to assign the worker to jobs with beryllium exposure, (2) initially determine what level of medical surveillance the responsible employer must provide to the particular worker, and (3) establish essential baseline data for each worker as criteria for assessing subsequent changes in health status attributable to beryllium exposure. Baseline medical examinations must include:

- C A detailed medical and work history with emphasis on past, current, and anticipated future exposure to beryllium;
- C A respiratory symptoms questionnaire;
- C A physical examination with special emphasis on the respiratory system, skin, and eyes;
- C A chest radiograph (posterior-anterior, 14 x 17 inches) interpreted by a NIOSH B-reader of pneumoconiosis or a board-certified radiologist (unless a baseline chest radiograph is already on file);

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- C Spirometry, including the forced vital capacity (FVC) and the forced expiratory volume at one second (FEV1);
- C The blood lymphocyte proliferation test (Be-LPT); and
- C Any other tests deemed appropriate by the examining physician for evaluating beryllium-related health effects.

DOE is not requiring the use of a specific standardized form or questionnaire for the baseline evaluation. However, appropriate standardized forms and questionnaires have been developed, and examples can be found at the following web site:

http://www.ornl.gov/cer/BMSP_pro/be-quest.htm

Use of these forms or similar tools is left to the discretion of the SOMD.

The pulmonary function tests (spirometry) are needed to provide baseline data on lung function and to permit evaluation of any future change in lung function. This information may also be useful in assessing the health of beryllium-associated workers who wear respirators.

Title 10 CFR 850.34(b)(2) establishes requirements for periodic evaluations. The periodic evaluations must be provided annually to beryllium workers and every three years to other beryllium-associated workers. The annual schedule for beryllium workers is intended to give priority for medical surveillance to workers who are at the greatest risk of exposure. This should ensure that those workers who are most in need of medical surveillance obtain it as soon as possible so that actions in response to positive medical findings can be taken as soon as possible.

The periodic medical evaluations must include: (1) a detailed medical and work history with emphasis on past, present, and anticipated future exposure to beryllium; (2) a respiratory symptoms questionnaire; (3) a physical examination with emphasis on the respiratory system; (4) the Be-LPT; and

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(5) any other tests deemed appropriate by the examining physician for evaluating beryllium-related health effects.

Title 10 CFR 850.34(b)(3) requires responsible employers to provide a medical evaluation as soon as possible to any worker who may have been exposed to beryllium because of a beryllium emergency. The medical evaluation must include the same elements as the periodic evaluation specified in 10 CFR 850.34(b)(2). The SOMD may determine that a medical evaluation of a worker shortly after a beryllium emergency is not necessary if the worker already participates in the beryllium medical surveillance program .

Medical surveillance using traditional screening tests has proven ineffective in detecting CBD in its early stages. A positive Be-LPT in peripheral blood lymphocytes indicates sensitization to beryllium and may be an early sign of CBD. The Be-LPT can be used as a diagnostic test, as a screening test, and as a surveillance tool. The incidence of positive peripheral blood Be-LPT results in exposed workers is considered to be an indicator of the occupational health impacts of beryllium exposure and a method for identifying populations at risk for CBD. A positive Be-LPT in lung lymphocytes combined with granulomas in the lung is considered to provide definitive support for a diagnosis of CBD. Many sensitized individuals, as identified by positive results on the Be-LPT, have developed CBD at a future date.

Table 4.5 presents a schedule of medical surveillance required by 10 CFR 850.34.

Table 4.5. Schedule of Medical Surveillance¹

	Baseline Medical Evaluation	Periodic Evaluation²	Emergency Evaluation³
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Detailed Medical and Work History Emphasis on past, present, and anticipated future exposure to beryllium	R	R	R
Respiratory Symptoms Questionnaire	R	R	R
Physical Examination	R Emphasis on respiratory system, skin, and eyes	R Emphasis on respiratory system	R Emphasis on respiratory system
Chest Radiograph (posterior-anterior)	R (unless a chest radiograph is already on file)	R (every five years)	R (unless a chest radiograph, that is less than five years old, is already on file)
Spirometry	R Forced vital capacity and forced expiratory volume at 1 second	D	D
Be-LPT	R	R	R
Other Tests Deemed Appropriate by Examining Physician⁴	D	D	D

R = Required by 10 CFR 850.

D = Discretionary component of surveillance to allow individual decisions on the risk versus benefits and because surveillance can be conducted without this procedure.

⁴For beryllium-associated workers who voluntarily participate.

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²Periodic evaluation must be conducted annually for beryllium workers; every three years for beryllium-associated workers.

³Only if determined necessary by the SOMD for workers who already participate in beryllium medical surveillance.

⁴For example, tests such as lung lavage-LPT, lung biopsy, or spirometry.

Under 10 CFR 850.34(c), the responsible employer must establish a multiple physician review process for beryllium-associated workers that allows for the review of initial medical findings, determinations, or recommendations from any medical evaluation conducted pursuant to 10 CFR 850.34. The beryllium-associated worker is allowed to designate a second physician to review any findings, determinations, or recommendations made by the initial physician if the responsible employer selects the initial physician to conduct the medical examination or consultation. The second physician may conduct any consultations, examinations, and laboratory tests that he or she deems necessary.

The responsible employer is required to notify the beryllium-associated worker of the right to seek a second medical opinion promptly after each occasion that an initial physician provided by the responsible employer conducts a medical exam or consultation. The responsible employer is permitted to make its participation in, and payment for, multiple physician review contingent on the beryllium-associated worker doing the following within 15 days after receipt of the initial physician's written opinion or receipt of the notice of the right to a second medical opinion:

- C Informing the responsible employer that he or she intends to seek a second medical opinion, and
- C Initiating steps to make an appointment with a second physician.

The responsible employer and the beryllium-associated worker must make efforts to encourage and assist the two physicians in resolving any disagreements between the two physicians on their medical findings, determinations, or recommendations. The responsible employer and the worker, acting through their respective physicians, must designate a third physician to resolve the disagreement if the two physicians still disagree. The third physician will review the previous findings and recommendations

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and may conduct any consultations, examinations, and laboratory tests that he or she deems necessary. The responsible employer is then required to act consistently with the findings and recommendations of the third physician, unless the responsible employer and the beryllium-associated worker reach an agreement that is consistent with the recommendations of at least one of the other physicians.

This multiple physician review process is consistent with the review process in OSHA's lead, cadmium, and benzene standards. The process is intended to:

- C Strengthen and broaden the bases for medical decisions in situations where a beryllium-associated worker questions the findings or recommendations of the initial physician;
- C Increase the worker's confidence in the soundness of the medical findings and recommendations; and
- C Increase workers' acceptance of and participation in the medical surveillance program.

The availability of a multiple physician review process allows workers to exercise their rights in an informed, knowledgeable way. Over time, this independent review is likely to show either that the worker's distrust of the physician retained by the responsible employer is unwarranted or that the responsible employer should improve the quality of medical surveillance being provided. If responsible employers are administering medical surveillance programs that maintain confidence, workers will see little or no need to seek second medical opinions.

Title 10 CFR 850.34(d) permits the responsible employer and the beryllium-associated worker to make other arrangements for an alternate form of physician determination in lieu of the multiple physician review process, so long as the alternative is expeditious and is at least as protective of the worker. For example, the parties might decide, in case of a dispute, to go directly to an agreed-upon final physician, skipping the initial physician chosen by the responsible employer and the second physician chosen by the worker.

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Title 10 CFR 850.34(e) requires the SOMD to provide the responsible employer with a written, signed medical opinion for each medical evaluation performed on each beryllium-associated worker within two weeks of receipt of the results. The written opinion must take into account the findings, determinations, and recommendations of the other examining physicians who may have examined the beryllium-associated worker. The SOMD's opinion must contain:

- C The diagnosis of the worker's condition relevant to occupational exposure to beryllium and any other medical condition that would place the worker at increased risk of material impairment as a result of further beryllium exposure;
- C Any recommendation for removal of the worker from DOE beryllium activities or for limitation of the worker's activities or duties or the use of PPE (e.g., respiratory protection); and
- C A statement that the SOMD or the examining physician has clearly explained to the worker the results of the medical evaluation, including all test results and any medical condition related to beryllium exposure that requires further evaluation or treatment.

The written medical opinion provided to the responsible employer must not reveal any specific records, findings, or diagnoses that are not related to the health effects of beryllium exposure.

Title 10 CFR 850.34(f) requires the SOMD to provide each beryllium-associated worker with a written medical opinion within 10 working days after the SOMD's receipt of the results of medical tests or procedures. The written opinion must contain the results of all medical tests or procedures, an explanation of any abnormal findings, and any recommendation that the worker be referred for additional testing for evidence of CBD.

The responsible employer must provide the beryllium-associated worker with the same information that is provided to the examining physician within 30 days after a request by the worker.

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Title 10 CFR 850.34(g) requires the responsible employer to report on the applicable OSHA reporting form (e.g., OSHA Form No. 200, the OSHA Injury and Illness Log) any beryllium sensitization, CBD, or any other abnormal condition or disorder of workers caused by or aggravated by occupational exposure to beryllium. Medical removal is considered to indicate an “abnormal condition.”

Responsible employers can use such information in determining whether the number of removals in various areas of the plant correlates with exposure levels. In this way, responsible employers can focus attention on areas of the plant where medical removals due to beryllium occur. Detailed instructions for illness and injury reporting are contained in Chapter (V)(E) of *Reporting Guidelines for Occupational Injuries and Illnesses* (ref. 27).

Title 10 CFR 850.34(h) requires responsible employers to analyze medical, job, and exposure data routinely and systematically to identify individuals or groups who are potentially at risk for CBD and to identify working conditions that are contributing to that risk. The responsible employer must determine which workers should be offered medical surveillance and must evaluate the need for additional exposure controls based on the results of these analyses. This data analysis provides a component of the linking of work place conditions and health outcomes required by 10 CFR 850.39(d) (see Section 4.2.19) and can be a component of the performance feedback required by 10 CFR 850.40 (see Section 4.2.20).

4.2.15 Medical Removal

Title 10 CFR 850.35 establishes the medical removal protection (MRP) provisions of the CBDPP. It addresses the medical basis for MRP, temporary and permanent removal, worker consultation, return to work, and MRP benefits. Medical surveillance can be effective in protecting workers’ health only when the workers voluntarily seek medical attention when they feel ill, refrain from efforts to conceal their true health status, and fully cooperate with examining physicians. With MRP, beryllium-associated

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workers are assured of being removed to jobs where beryllium exposure is low when necessary to protect their health. With MRP benefits, they are assured that, if they fully participate in medical surveillance and are removed from their beryllium-associated jobs, their wages and job status will be protected for a sufficient period of time to allow for retraining and placement in another job, or in certain circumstances, return to their beryllium activity job. Worker participation in medical removal is voluntary.

Title 10 CFR 850.35(a) requires responsible employers to offer beryllium-associated workers removal from exposure to beryllium if the SOMD determines in a written medical opinion that it is medically appropriate to do so. The SOMD's determination must be based on one or more positive Be-LPT results, a diagnosis of CBD, an examining physician's recommendation, or any other signs or symptoms that the SOMD deems medically sufficient. Medical removal can be temporary or permanent.

Temporary removal is offered to a worker pending a final medical determination of whether the worker should be removed permanently. Final determination is dependent on the outcome of the multiple physician review process or the alternate medical determination process (discussed in Section 4.2.14.).

The responsible employer is required to transfer the worker to a comparable job for which the worker is qualified (or for which the worker can be trained in a short time) and where beryllium exposures are as low as possible (but in no event above the action level) if the worker accepts temporary medical removal. The responsible employer must maintain the beryllium-associated worker's total normal earnings, seniority, and other worker rights and benefits as if the worker had not been removed during temporary removal. The responsible employer must provide these benefits until a job becomes available or for one year, whichever comes first if no such job is currently available.

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The responsible employer must offer the beryllium-associated worker permanent removal if the final SOMD's determination is a recommendation for permanent removal. Permanent MRP benefits are described below.

Workers need adequate information before they make decisions concerning temporary or permanent removal. For this reason, 10 CFR 850.35(a)(3) requires the SOMD to:

- C Advise the beryllium-associated worker of the determination that medical removal is necessary to protect the worker's health;
- C Provide the worker with a copy of 10 CFR 850, its preamble, and any other information the SOMD deems necessary to illustrate the benefits of removal and the risks of continued beryllium exposure;
- C Provide the worker an opportunity to have any questions about MRP answered; and
- C Obtain the worker's signature acknowledging that the worker has been advised to accept medical removal from beryllium exposure and has been provided with information on the risks of continued exposure and the benefits of removal.

Title 10 CFR 850.35(a)(4) prohibits responsible employers from returning a worker who has been permanently removed (for any reason) to the worker's former job status unless the SOMD determines in a written medical opinion that continued medical removal is no longer necessary to protect the worker's health. If the SOMD determines that continued exposure to beryllium will not pose an increased risk to the beryllium-associated worker's health and that medical removal is an inappropriate remedy under the circumstances, the SOMD must fully discuss these matters with the worker and then may, in a written determination, authorize the responsible employer to return the worker to his or her former job status. The responsible employer must continue to provide medical surveillance to beryllium-associated workers who return to work from medical removal.

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The rule permits some flexibility where it is reasonably clear that returning the worker to his or her normal job is unlikely to affect the worker's health and the alternative is much more drastic for the worker. For example, returning a worker to a beryllium-associated job might be justified if, after two years of removal, the worker is not experiencing a decrease in lung function, the worker is nearing retirement and termination of employment would mean the loss of pension benefits, and the time the worker will be exposed at or above the action level is very limited (e.g., a few months). In such cases, the SOMD may recommend the responsible employer provide the worker with additional protection such as a positive-pressure, supplied-air respirator. In any event, the decision to return the worker can be made only after the SOMD has consulted with the worker and fully explained the relevant facts and prognoses.

Title 10 CFR 850.35(b) requires responsible employers to provide benefits for workers who have been permanently removed from beryllium exposure. These benefits include:

- C The opportunity to transfer to another position, which is available or later becomes available, for which the worker is qualified (or for which the worker can be trained) and where beryllium exposures are as low as possible, but in no event higher than the action level; or
- C A maximum of 2 years of MRP benefits if the worker cannot be transferred to a comparable job where beryllium exposures are below the action level. These MRP benefits are defined as maintenance of total normal earnings, seniority, and other worker rights and benefits as though the worker had not been removed.

MRP benefits must include the amount of overtime pay typically earned on the job from which a worker was removed as part of the worker's total earnings if the worker would have continued to earn the overtime pay during the removal period.

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The responsible employer must continue to provide MRP benefits pending disposition of the claim if a removed worker files a workers' compensation claim for a beryllium-related disability. The responsible employer must reduce MRP benefits by the amount of any workers' compensation award received by the worker for earnings lost during medical removal. The MRP benefits cannot be reduced because of workers' compensation payments received by the worker for treatment-related expenses. Similarly, the MRP benefits will be reduced to the extent that the worker receives compensation for lost earnings from a publicly or employer-funded compensation program or from employment with another employer made possible by virtue of the worker's removal. These MRP benefits are not intended to expand upon, restrict, or change any rights to a specific job classification or position under the terms of an applicable collective bargaining agreement.

Title 10 CFR 850.35(b)(6) gives employers the authority to make provision of MRP benefits contingent on the worker's participation in the beryllium medical surveillance program.

4.2.16 Medical Consent

Title 10 CFR 850.36 establishes the medical consent provisions of the CBDPP. Because worker participation in medical surveillance is voluntary, the medical consent is necessary to ensure that beryllium workers receive the information needed to make an informed decision regarding their participation in the program.

The responsible employer must provide beryllium-associated workers with a summary of the medical surveillance program at least one week before the medical evaluation or procedure or at any time requested by the worker. The summary must include:

- C The type of data that will be collected in the medical surveillance program;
- C How the data will be collected and maintained;

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- C The purpose for which the data will be used; and
- C A description of how confidential data will be protected.

Responsible employers must also provide beryllium-associated workers with information on the benefits and risks of the medical tests and examinations available to them at least one week before the test or exam. DOE expects responsible employers to make reasonable efforts to help workers understand the information. As an example, workers should receive an explanation of how the Be-LPT works and the possibility for false positive and false negative results. The presented information should be appropriate in content and vocabulary to the education level, literacy, and language background of the worker.

Workers must be given an opportunity to have their questions answered.

The responsible employer must have the SOMD obtain a signed, informed-consent form from the beryllium-associated worker before performing any medical evaluations or tests. The form is included as Appendix A to 10 CFR 850.

4.2.17 Training and Counseling

Title 10 CFR 850.37 requires responsible employers to develop and implement a beryllium training program for beryllium-associated workers and all other individuals who work at a site where beryllium activities are conducted. The responsible employer must ensure participation in the training. Title 10 CFR 850.37 also requires responsible employers to develop and implement a counseling program to assist beryllium-associated workers who are diagnosed by the SOMD to be sensitized to beryllium or have CBD.

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4.2.17.1 Training

The training for beryllium-associated workers must cover the contents of the CBDPP and must address potential health risks to family members and others who may come into contact with beryllium on the workers, their clothing, or their personal items as the result of a beryllium control failure at a DOE facility. This training must be conducted in accordance with 29 CFR 1910.1200, *Hazard Communication* (ref. 28). DOE does not intend for responsible employers to implement separate and redundant training to comply with both 10 CFR 850 and the HAZCOM standard. Rather, DOE expects responsible employers to integrate their CBDPP training into existing HAZCOM training programs, thus minimizing the burden on employers and providing for a consistent approach to worker training and communication of hazards.

The training provided for all other individuals who work at a site where beryllium activities are conducted must consist of general awareness about beryllium hazards and controls.

DOE expects responsible employers to conduct training in a manner that is easy to understand so that workers can effectively translate the training into safe work practices. Training material should be appropriate in content and vocabulary to the education level, literacy, and language background of affected workers. Responsible employers may wish to consult Appendix E of 29 CFR 1910.1200, which addresses principles for adult education.

The Office of Occupational Medicine and Medical Surveillance (EH-61) has provided a set of materials that responsible employers may use in training workers about the health hazards of beryllium. Those materials can be found on-line at the following web site:

<http://tis.eh.doe.gov/med/commbe/>

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DOE endorses two training videos, “Beryllium Disease” (ref. 36) and “Beryllium” (ref. 37).

Responsible employers may find additional useful information for beryllium training on the DOE CBDPP web site at:

<http://tis.eh.doe.gov/be/>

The responsible employer must provide beryllium training before or at the time of the worker’s initial assignment to the job and at least every two years thereafter. The responsible employer must also provide retraining whenever there is reason to believe that a beryllium worker lacks the proficiency, knowledge, or understanding needed to work safely with beryllium. Title 10 CFR 850.37(e) cites two situations where retraining would be needed:

- C To address any new beryllium hazards resulting from a change in operations, procedures, or controls about which the beryllium worker was not previously trained; and
- C When a beryllium worker’s performance involving beryllium work indicates that the worker has not retained the requisite proficiency.

Periodic training is necessary to reinforce and update initial training. The periodic training should not be merely a repeat of the initial training. How often training is provided should be determined using a risk-based approach. Examples of when more frequent training would be appropriate include when the risk for exceeding the action level is high, when the effectiveness of exposure reduction and minimization strategies is marginal or not proven, or when activities and processes are complex or highly variable.

DOE previously has issued requirements and guidance with regard to education, training, and skills for many categories of personnel, including individuals responsible for developing and implementing measures necessary for ensuring compliance with OSHA safety requirements. Some of these requirements are addressed in DOE O 440.1A, *Worker Protection Management for DOE Federal*

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and Contractor Employees (ref. 2). This Order establishes training and qualification requirements for technical professionals and management personnel involved with worker protection at DOE facilities. While these requirements may not be mandatory at a specific site, this information may be useful for all DOE facilities in developing training programs and standards for the education, training, and skills appropriate for personnel to achieve compliance with the requirements of 10 CFR 850.

4.2.17.2 Counseling

Title 10 CFR 850.37(f) requires responsible employers to develop and implement a counseling program to assist beryllium-associated workers who have been diagnosed to be sensitized to beryllium or to have CBD. The purpose of this counseling is to communicate to workers information that may help them make important health- and work-related decisions and become aware of administrative activities, such as filing workers' compensation claims. In addition to educating workers about CBD and related medical and career options, counseling can also provide workers diagnosed to be sensitized to beryllium or to have CBD with needed emotional support to deal with the fear, anxiety, anger and depression that they may experience as a result of their diagnosis. Counseling should be developed in consultation with beryllium-associated workers, as well as any labor organizations that may represent these workers for collective bargaining.

The counseling program must provide sensitized and CBD-diagnosed workers with information pertaining to (1) the medical surveillance program; (2) medical treatment options; (3) medical, psychological, and career counseling; (4) medical benefits; (5) administrative procedures and workers' rights under workers' compensation laws and regulations; (6) work practices designed to limit exposure to beryllium; and (7) the risk of continued exposure after sensitization. Responsible employers should consider:

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- *Medical surveillance program.* Responsible employers must communicate the medical surveillance program established under 10 CFR 850.34, including multiple physician review, alternate physician determination, information provided to the beryllium-associated worker, and any other relevant information regarding what workers with sensitization to beryllium or CBD can expect from the medical surveillance program.
- *Medical treatment options.* Responsible employers must provide the worker with information regarding medical treatment options. This information should include a description of associated benefits, risks, possible side effects, etc., to allow workers to make informed decisions regarding their health care.
- *Medical, psychological, and career counseling.* Responsible employers must have the ability to address a workers' medical, psychological, and career planning needs by providing the worker with appropriate counseling.
- *Medical benefits.* Workers diagnosed to be sensitized to beryllium or have CBD must be informed of available medical benefits. This information must include a description of medical removal protection benefits, as provided for under 10 CFR 850.35, that assures workers that, if the results of medical surveillance require removal from their beryllium exposed jobs, their normal earnings and job status will be protected for the time periods specified in the rule (see Section 4.2.15).
- *Administrative procedures and workers' rights under workers' compensation laws and regulations.* Responsible employers must inform workers of their rights and the administrative procedures under applicable workers' compensation laws and regulations. Contractor Benefits Administrators and Loss Control Managers are key resources to assist in providing this counseling. Responsible employers may also wish to advise workers to consult with their own attorneys on

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these matters. Workers' compensation laws vary from state to state for private employees.

Federal employees are covered by the Federal Employees' Compensation Act (FECA), which provides for workers' compensation coverage administered by the Office of Workers' Compensation Programs (OWCP) Division of Federal Employees' Compensation within the Department of Labor, Employment Standards Administration. Additional FECA information and resources are available at:

<http://www.dol.gov/dol/esa/public/regs/compliance/owcp/fecacont.htm>

Additional state workers' compensation information is available by contacting the applicable state workers' compensation official listed at:

<http://www.dol.gov/dol/esa/public/regs/compliance/owcp/wc.htm>

- *Work practices designed to limit exposure to beryllium.* Responsible employers must counsel employees with regard to work practices that are designed to limit exposure. These include following procedures for regulated areas, hygiene facilities and practices, respiratory protection, protective clothing and equipment, housekeeping, beryllium emergencies, and warning signs and labels (see Sections 4.2.6, 4.2.7, 4.2.8, 4.2.9, 4.2.10, 4.2.13, and 4.2.18).
- *Risk of continued exposure after sensitization.* Responsible employers must inform workers of the risk of continued exposure after sensitization. It is medically prudent to prevent additional exposure to beryllium once sensitization has occurred.

Responsible employers may implement the counseling program through several different options including one-on-one counseling with a physician or other counselor and coordination of support groups to provide a forum for sensitized and CBD-diagnosed workers to discuss issues with the support of peers with similar concerns and obtain information from invited experts. Responsible

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employers may supplement these options with use of printed material, such as fact sheets or brochures, to provide information to workers.

Responsible employers may find information that can be useful for the counseling program on the DOE Chronic Beryllium Disease Prevention Program (CBDPP) web site at:

<http://tis.eh.doe.gov/be/>

and in the DOE Training Reference for Beryllium Workers and Managers/Supervisors entitled “Communicating Health Risks, Working Safely With Beryllium,” May 1998, found at:

<http://tis.eh.doe.gov/med/commbe/>

Support groups for sensitized and CBD-diagnosed workers are identified at:

http://www.dimensional.com/~mhj/support_groups.html

4.2.18 Warning Signs and Labels

Title 10 CFR 850.38 requires responsible employers to (1) post warning signs at each access point to beryllium regulated areas and (2) affix warning labels to containers of beryllium, beryllium compounds, or beryllium-contaminated items. Proper exposure control of beryllium requires that its presence be clearly identified to all who might possibly be exposed. The purpose of the warning signs and labels is to ensure that all affected individuals, not only those previously identified as potentially exposed to beryllium, are appraised of the potential hazards of beryllium exposures. The posting of signs serves as a warning to workers who may otherwise not know they are entering a regulated area where beryllium exposure may occur.

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Regulated areas, as discussed in Section 4.2.6, may often exist on a temporary basis such as during maintenance, D&D operations, or in emergency situations. The use of warning signs under these circumstances is of particular importance because maintenance, D&D, or an emergency could present new or unexpected potential for exposure to workers who are regularly expected to conduct work unrelated to beryllium at these locations. All access points to regulated areas must be clearly identified with warning signs containing the following information:

**DANGER
BERYLLIUM CAN CAUSE LUNG DISEASE
CANCER HAZARD
AUTHORIZED PERSONNEL ONLY**

In addition to posted area signs, all containers of beryllium, beryllium compounds, beryllium parts, or beryllium-contaminated clothing, waste, scrap, or debris must have a prominent warning label. These provisions must conform to OSHA's Hazard Communication Standard (ref. 28). The label must convey the following information:

**DANGER
CONTAMINATED WITH BERYLLIUM
DO NOT REMOVE DUST BY BLOWING OR SHAKING
CANCER AND LUNG DISEASE HAZARD**

Responsible employers must also consider the potential for internal contamination of equipment (see Section 4.2.11). In some cases, internal beryllium contamination would not pose a health hazard unless the equipment is disassembled. Additional labeling should be used to alert workers of the potential hazard. Examples of such labels include:

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CAUTION
POSSIBLE BERYLLIUM CONTAMINATION
INHALATION OF DUST OR FUMES MAY CAUSE
SERIOUS CHRONIC LUNG DISEASE

This equipment was in a building where beryllium manufacturing operations were performed. This equipment was not used in beryllium operations but may be internally contaminated. If the internal components of this equipment are breached, workers must be protected in accordance with applicable OSHA standards. Surveys were performed to determine the presence of external surface contamination. Survey results are packaged with the equipment.

CAUTION
BERYLLIUM CONTAMINATION
INHALATION OF DUST OR FUMES MAY CAUSE
SERIOUS CHRONIC LUNG DISEASE

This equipment was known to have been used for beryllium operations and may be internally contaminated. If the internal components of this equipment are breached, workers must be protected in accordance with applicable OSHA standards. Surveys were performed to determine the levels of external surface contamination. Survey results are packaged with the equipment.

There are two features of a proper warning: adequate communication and adequate content. In other words, the emphasis is on visibility and wording effectiveness in informing workers of beryllium's

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potential to cause serious disease. Detailed specifications for warning signs and labels, such as size, color, or other physical attributes, must conform to the requirements of 29 CFR 1910.145. It is the responsibility of the responsible employer to design, produce, and use signs and labels of appropriate size, color, contrast, etc., so that the signs and labels are easily visible to workers. OSHA's Hazard Communication standard [29 CFR 1910.1200(f)(9)] states that "employers having employees who speak other languages may add information in their language to the material presented, as long as the information is presented in English as well."

4.2.19 Recordkeeping and Use of Information

Title 10 CFR 850.39 requires responsible employers to establish and maintain accurate records of all beryllium inventory information, hazard assessments, exposure measurements, exposure controls, and medical surveillance. The Heads of DOE Departmental Elements (typically the Operations Office Manager or DOE Facility Manager) must designate beryllium records as "agency records" that must be retained for a minimum of 75 years. The responsible employer must convey to DOE or its designee all records required under 10 CFR 850 if the responsible employer ceases to be involved in the CBDPP. Successive employers should use consistent record retrieval identifiers to ensure that records of interest are readily available.

Title 10 CFR 850.39 also requires responsible employers to:

- C Link data on workplace conditions and health outcomes in order to establish a basis for understanding the beryllium health risk (see Section 4.2.14);
- C Ensure the confidentiality of all work-related CBDPP records;
- C Maintain all records required by 10 CFR 850 in current and accessible electronic systems that include the ability to retrieve data readily in a format that maintains confidentiality;

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- C Transmit all records generated as required by 10 CFR 850 to the DOE Assistant Secretary for Environment, Safety, and Health on request in a format that protects the confidentiality of individuals; and
- C Semi-annually transmit to the DOE Office of Epidemiologic Studies an electronic registry of beryllium-associated workers.

An example of linking data on workplace conditions and health outcomes is the epidemiological study described in Kreiss et al., "Machining Risk of Beryllium Disease and Sensitization with Median Exposures Below 2 $\mu\text{g}/\text{m}^3$ " (ref. 29).

DOE must, to the maximum extent allowed by law, make available to the public all records required by 10 CFR 850, while preserving essential confidentiality, consistent with the Freedom of Information Act. As stated in an October 4, 1993, Presidential Memorandum, "Federal departments and agencies should handle requests for information in a customer-friendly manner. The use of the Act by ordinary citizens is not complicated, nor should it be. The existence of unnecessary bureaucratic hurdles has no place in its implementation." The Freedom of Information Act identifies nine exceptions to the release of government information. Those exceptions are contained in other laws that establish confidentiality for purposes such as privacy, national security, and patents and trademarks.

To maintain confidentiality of records, the responsible employer must ensure that all records that are transmitted to other parties do not contain names, social security numbers, or any other information that could be used to identify particular individuals. Title 10 CFR 850.39 also contains several confidentiality requirements concerning medical information. Individual medical information generated by the CBDPP must be:

- C Included as part of the worker's site medical records and maintained by the SOMD or by another physician designated by the responsible employer;

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- C Maintained separately from personal records; and
- C Used or disclosed by the responsible employer only in conformance with applicable laws (e.g., the Americans with Disabilities Act, the Privacy Act of 1974, and the Freedom of Information Act).

Title 10 CFR 850.39(h) requires responsible employers to transmit an electronic beryllium registry semi-annually to the DOE Office of Epidemiologic Studies within the Office of Environment, Safety and Health. The registry must include, but is not limited to, a unique identifier, date of birth, gender, site, job history, medical screening test results, exposure measurements, and results of referrals for specialized medical evaluations. DOE will use the registry to determine the exposure profile and disease status of groups of beryllium-associated workers and to provide feedback to responsible employers on the overall effectiveness of CBDPPs. The registry will give DOE the ability to combine data from different facilities and perform analyses that are impossible to perform with the small amount of data available from each individual facility. Research studies using the registry will provide very important information about beryllium disease and working conditions for groups of workers, but not for individual cases of CBD. Individual cases must be followed by the SOMD. Appendix D discusses the registry in greater detail.

Specific information generated from CBDPP activities and required by 10 CFR 850.39 is discussed in various sections of this implementation guide including Sections 4.2.1, “Baseline Beryllium Inventory”; 4.2.2, “Hazard Assessment”; 4.2.4, “Exposure Monitoring”; and 4.2.14, “Medical Surveillance.” The following is a consolidation of minimum information that must be maintained:

- C Baseline hazard information: beryllium and beryllium contamination inventory, facility and process descriptions including diagrams, cost codes that link workers to tasks that involve beryllium, and building and room numbers identified as having the presence or potential presence of beryllium; documentation of the strategy used in determining that the baseline is comprehensive and

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explanations of why the spaces and processes not shown in the baseline are unlikely to contain beryllium hazards.

- C Exposure group information: personal and unique identifiers, job, task, and location, whether the worker is current or former, whether the worker has had known exposures or potential incidental exposures, and other information that can be used to link beryllium exposure information to individuals and medical records.
- C Records of individuals who enter regulated areas: name, date, time entered and left, location, activities performed in the area location, and respirator and PPE worn.
- C Hazard assessment and industrial hygiene reports: methods, assumptions, conclusions, and recommendations.
- C Medical records: diagnoses and clinical results, worker's and group exposures, and medical and work histories.
- C Exposure monitoring: dates, locations, and chemical and physical characteristics and morphology of beryllium contaminants; methods; results; the type of respiratory protective equipment worn; the identity of workers and exposure groups monitored; indication of whether the purpose of the monitoring was to characterize personal exposure or characterize a process.
- C Types of control methods in use: design and measured levels of control.
- C Investigative reports: accidental releases or unexpected high monitoring results.
- C Worker concerns and occurrence reports that indicate breaches in the worker protection program.

The physician responsible for medical services should outline procedures for the creation and maintenance of a medical record for each worker who is identified as exposed or potentially exposed to airborne beryllium. Responsible employers are required to maintain medical monitoring records for all workers who are subject to the beryllium medical surveillance program. Medical records should include the following:

- C Copies of the attending physician's written reports;

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- C A copy of the worker's occupational medicine history;
- C Results of all medical tests including additional tests recommended by the physician;
- C A description of any worker medical complaints which may be related to beryllium exposure; and
- C Original x-ray films.

Cases of CBD are required to be investigated and reported in accordance with DOE O 231.1 (ref. 30) when this order is referenced in the responsible employer's contract. One goal of this investigation report is to create CBD case descriptions that can be grouped for analysis. The narrative portion of investigation reports should include: (1) a work history collected through a review of personnel records and an interview; (2) a summary of exposure records, which should include descriptive statistics such as range, mean, standard deviation, or alternatively, percent exceedance of action levels; and (3) a characterization of the clinical stage of the disease such as alveolitus, granuloma, or fibrosis and whether treatment has been prescribed.

4.2.20 Performance Feedback

Title 10 CFR 850.40 requires responsible employers to conduct period analyses and assessments of monitoring activities, hazards, medical surveillance, exposure reduction and minimization, and occurrence reporting data. Responsible employers must give the results of these analyses and assessments to line managers, planners, worker protection staff, medical staff, workers, and labor organizations representing beryllium-associated workers who request such information. DOE intends that this information be available to maintain and continuously improve all elements of the CBDPP.

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4.2.20.1 Performance Measurement

Performance measurement is necessary to determine whether CBDPP goals are being achieved and to provide feedback to help understand, manage, and improve CBDPP implementation. The performance measurement process consists of determining what to measure, identifying data collection methods, and collecting data. An overview of this process, as well as performance assessment, can be found in DOE G 120.1-5, *Guidelines for Performance Measurement* (ref. 31). Additional general information on goals and performance measures can be found in DOE's Training Resources and Data Exchange (TRADE) organization's *How To Measure Performance: A Handbook of Techniques and Tools* (ref. 39).

The responsible employer should employ both outcome and output measures to determine the effectiveness of CBDPP elements and achievement of program goals (e.g., exposure reduction and minimization). Outcome measures are an assessment of the results of a program activity or effort compared to its intended purpose. Possible CBDPP outcome measures include:

- C Exposure level measures for groups and individuals such as arithmetic means or percent exceeding the PEL, the action level, or detection limits;
- C Incidence of CBD and beryllium sensitization;
- C Number of workers potentially exposed;
- C Percent of surface wipe samples exceeding the housekeeping limit;
- C Area (square feet) outside operational area with removable surface contaminated ≥ 0.2 Fg/100 cm²,
- C Beryllium-contaminated waste (cubic feet), and
- C Results of analyses of occurrence reports.

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Output measures are the tabulation, calculation, or recording of an activity or effort and can be expressed in a quantitative or qualitative manner. These measures do not necessarily indicate direct causal relationship for program outcomes, but they can be useful indicators of program elements that may be contributing to poor performance and undesirable outcomes. Output measures that are potentially useful in managing the implementation of a CBDPP include:

- C Percent of hazard assessments completed per month,
- C Percent of beryllium-associated workers participating in scheduled medical surveillance per month,
- C Percent of beryllium-associated workers completing scheduled hazard communication training per month,
- C Percent of site workers completing scheduled general employee beryllium awareness training per month,
- C Percent of the site's facilities that have completed baseline inventories and sampling per month, and
- C Percent of beryllium-associated workers who received personal monitoring that were targeted for this monitoring in the site's CBDPP.

4.2.20.2 Performance Assessment

Evaluating the performance of the CBDPP consists of periodic program assessments and routine surveillance (i.e., analysis) of program elements. Assessments should be coordinated with, but not replaced by, DOE independent oversight inspections or annual evaluations. Program assessments should focus on organizations at all levels (department, division, section, individual workers, and subcontractors) and should involve an open reporting process (i.e., without fear of reprisal). To be effective, responsible employers should tie assessments to CBDPP performance measures and should involve assessment methods such as visual monitoring of work processes, review of beryllium process and hazards data, procedural reviews, and worker qualification and training reviews. Assessments

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should be conducted at least annually, although 10 CFR 850.40 does not specify a minimum frequency for conducting assessments.

Surveillance is closely related to performance assessment but includes routine analyses with the goal of identifying potential problems where intervention can improve performance. The following definition is from the Council of State and Territorial Epidemiologists:

“Surveillance is the ongoing, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those who need to know. The final link in the surveillance chain is the application of these data to prevention and control.”

Medical surveillance analyzes health and clinical data for higher-than-expected incidence or sentinel events, such as CBD diagnoses or beryllium sensitization, to determine if corrective actions can prevent a recurrence. The physicians providing medical surveillance should be familiar with working conditions, have access to exposure information, have the authority to report findings and make recommendations directly to line management, and deliver summaries and impacts of medical surveillance results to appropriate personnel. Beryllium training should include this medical surveillance information.

Similarly, exposure surveillance includes the routine analysis of exposure data with the aim of identifying occupational exposures that require additional control. Exposures that are out of compliance with the PEL must be investigated to determine their cause and to determine corrective actions that can prevent a recurrence. Control charts of beryllium exposure levels and other analytical tools can be used to identify working conditions that require further investigation.

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4.2.20.3 Feedback and Improvement

Active performance feedback mechanisms are essential for day-to-day implementation and continual improvement of each element of the CBDPP. Useful feedback can best be achieved by having a multi-disciplinary team collaborate on current beryllium issues. Such teams should include representatives of line management, workers, maintenance, and safety functions. “Plan of the Day” meetings or other daily or weekly project and operations meetings involving these individuals are essential in providing real-time feedback on work plans, standard operating procedures, safety issues, or performance problems. Post-job interviews and meetings also yield important insights that can be factored into subsequent work activities.

Another important feedback mechanism is lessons learned. These include good work practices or innovative approaches that are captured and shared to improve work, as well as adverse work practices or experiences that should be shared to avoid their recurrence. A systematic process for the collection and dissemination of lessons learned information should be established. Example sources of lessons learned information include project summary reports, injury and illness reports, occurrence reports, DOE safety notices, and DOE Safety and Health Bulletins. DOE-STD-7501-95, *DOE Lessons Learned Technical Standard* (ref. 32), and DOE-HDBK-7502-95, *DOE Lessons Learned Handbook* (ref. 33), provide further information on collecting lessons learned. The following web site provides information and links dealing with DOE's Lessons Learned program:

<http://tis.eh.doe.gov/ll/>

Another critical element of continuously improving performance is a systematic method for tracking corrective actions. This activity is consistent with the objectives of “hazard abatement tracking” as discussed in DOE G 440.1-1, *Implementation Guide for Worker Protection Management for DOE Federal and Contractor Employees* (ref. 34). Computerized information systems are a good

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tool for systematically organizing corrective actions, assigning responsibility, and tracking the completion or delay of any actions. Information should be easily retrievable and routinely monitored and updated.

Examples of beryllium-related information that should be tracked include:

- C Description of surveillance or assessment findings such as program deficiencies (e.g., inadequate beryllium controls, poor monitoring practices, lack of worker involvement);
- C Date and location of findings;
- C Description of and planned completion dates for planned corrective actions;
- C Identification of organization/individual responsible for corrective actions; and
- C Identifying number for tracking corrective actions.

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Appendix A

CROSSWALK TO APPLICABLE DOE DIRECTIVES

The following matrix provides a crosswalk for the guidance provided in this implementation guide to 10 CFR 850 and the directives and guidance contained in DOE O 440.1A and its implementation guides.

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DOE G XXXX Paragraph No.	Applicable Regulation, Directive, or Guidance	Requirement and Associated Guidance
4.1 CBDPP Plan	10 CFR 850	<p>850.10. Development and Approval of the CBDPP</p> <p>(a) <u>Preparation and submission of initial CBDPP to DOE.</u> (1) The responsible employer at a DOE facility must ensure that a CBDPP is prepared for the facility and submitted to the appropriate Head of DOE Field Element before beginning beryllium activities, but no later than [90 days after the effective date of the final rule] of this part. (2) If the CBDPP has separate sections addressing the activities of multiple contractors at the facility, the Head of DOE Field Element will designate a single DOE contractor to review and approve the sections prepared by other contractors, so that a single consolidated CBDPP for the facility is submitted to the Head of DOE Field Element for review and approval.</p> <p>(b) <u>DOE review and approval.</u> The appropriate Head of DOE Field Element must review and approve the CBDPP. (1) The initial CBDPP and any updates are deemed approved 90 days after submission if they are not specifically approved or rejected by DOE earlier. (2) The responsible employer must furnish a copy of the approved CBDPP, upon request, to the DOE Assistant Secretary for Environment, Safety and Health or designee, DOE program offices, and affected workers or their designated representatives.</p> <p>(c) <u>Update.</u> The responsible employer must submit an update of the CBDPP to the appropriate Head of DOE Field Element for review and approval whenever a significant change or significant addition to the CBDPP is made or a change in contractors occurs. The Head of DOE Field Element must review the CBDPP at least annually and, if necessary, require the responsible employer to update the CBDPP.</p> <p>(d) <u>Labor Organizations.</u> If a responsible employer employs or supervises beryllium-associated workers who are represented for collective bargaining by a labor organization, the responsible employer must: (1) Give the labor organization timely notice of the development and implementation of the CBDPP and any updates thereto; and (2) Upon timely request, bargain concerning implementation of this part, consistent with the Federal labor laws.</p>

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	10 CFR 850 (Cont.)	<p>850.11 General CBDPP requirements.</p> <p>(a) The CBDPP must specify the existing and planned operational tasks that are within the scope of the CBDPP. The CBDPP must augment and, to the extent feasible, be integrated into the existing worker protection programs that cover activities at the facility.</p> <p>(b) The detail, scope, and content of the CBDPP must be commensurate with the hazard of the activities performed, but in all cases the CBDPP must:</p> <p>(1) Include formal plans and measures for maintaining exposures to beryllium at or below the permissible exposure level prescribed in section 850.22;</p> <p>(2) Satisfy each requirement in subpart C of this part;</p> <p>(3) Contain provisions for:</p> <p>(i) Minimizing the number of workers exposed and potentially exposed to beryllium;</p> <p>(ii) Minimizing the number of opportunities for workers to be exposed to beryllium;</p> <p>(iii) Minimizing the disability and lost work time of workers due to chronic beryllium disease, beryllium sensitization and associated medical care; and</p> <p>(iv) Setting specific exposure reduction and minimization goals that are appropriate for the beryllium activities covered by the CBDPP to further reduce exposure below the permissible exposure limit prescribed in section 850.22.</p>
	DOE O 440.1A	<p>4.a. and Attachment 2, 1: Implement a written worker protection program that:...provides a place of employment free from recognized hazards that are causing or are likely to cause death or serious physical harm to their employees; and...integrates all requirements contained in paragraphs 4a through 4l of this Order; program requirements, contained in Title 29 Code of Federal Regulations (CFR) Part 1960, "Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters"; applicable functional area requirements contained in Attachment 1; and other related site-specific worker protection activities.</p> <p>4.b and Attachment 1, 2: Establish written policy, goals, and objectives for the worker protection program.</p>

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4.2.1 Baseline Beryllium Inventory	10 CFR 850	<p>850.20 Baseline beryllium inventory.</p> <p>(a) The responsible employer must develop a baseline inventory of the locations of beryllium operations and other locations of potential beryllium contamination, and identify the workers exposed or potentially exposed to beryllium at those locations.</p> <p>(b) In conducting the baseline inventory, the responsible employer must:</p> <ol style="list-style-type: none"> (1) Review current and historical records; (2) Interview workers; (3) Document the characteristics and locations of beryllium at the facility; and (4) Conduct air, surface, and bulk sampling. <p>(c) The responsible employer must ensure that:</p> <ol style="list-style-type: none"> (1) The baseline beryllium inventory is managed by a qualified individual (e.g., a certified industrial hygienist); and (2) The individuals assigned to this task have sufficient knowledge and experience to perform such activities properly.
	DOE O 440.1A	<p>4.i: Identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness.</p> <p>Attachment 1, 5.a: Initial or baseline surveys of all work areas or operations to identify and evaluate potential worker health risks.</p>
	DOE G 440.1-3	<p>4.4.1 provides guidance about initial hazard identification as the first step in determining potential worker exposures.</p>
4.2.2 Hazard Assessment	10 CFR 850	<p>850.21 Hazard assessment.</p> <p>(a) If the baseline inventory establishes the presence of beryllium, the responsible employer must conduct a beryllium hazard assessment that includes an analysis of existing conditions, exposure data, medical surveillance trends, and the exposure potential of planned activities. The exposure determinants, characteristics and exposure potential of activities must be prioritized so that the activities with the greatest risks of exposure are evaluated first.</p> <p>(b) The responsible employer must ensure that:</p> <ol style="list-style-type: none"> (1) The hazard assessment is managed by a qualified individual (e.g., a certified industrial hygienist); and (2) The individuals assigned to this task have sufficient knowledge and experience to perform such activities properly.
	DOE O 440.1A	<p>4.i.(1): Analyze or review: (a) designs for new facilities and modifications to existing facilities and equipment; (b) operations and procedures; and (c) equipment, product, and service needs.</p> <p>4.i.(3): Evaluate workplaces and activities accomplished routinely by workers, supervisors, and managers and periodically by qualified worker protection professionals.</p> <p>4.i.(4): Report and investigate accidents, injuries, and illnesses (reference DOE O 231.1, 232.1, and 225.1) and analyze related data for trends and lessons learned (reference DOE O 210.1).</p>

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	DOE G 440.1-1	4.3.1 discusses the types of analyses and reviews that can be useful in identifying and evaluating hazards. 4.3.3 gives guidance on effective approaches to routine evaluation of workplaces and activities.
	DOE G 440.1-3	4.4.6 provides guidance for conducting qualitative exposure monitoring, including development of exposure profiles, identification of exposure groups, and use of administrative control limits.
4.2.3 Exposure Limit and Action Level	10 CFR 850	850.22 Permissible Exposure Limit. The responsible employer must assure that no worker is exposed to an airborne concentration of beryllium greater than the permissible exposure limit established in 29 CFR 1910.1000, as measured in the worker's breathing zone by personal monitoring or a more stringent TWA PEL that may be promulgated by the Occupational Safety and Health Administration. 850.23 Action level. (a) The responsible employer must include in its CBDPP an action level that is no greater than 0.2 µg/m ³ , calculated as an 8-hour TWA exposure, as measured in the worker's breathing zone by personal monitoring. (b) If an airborne concentration of beryllium is at or above the action level, the responsible employer must implement sections 850.24(c) (periodic monitoring), 850.25 (exposure reduction and minimization), 850.26 (regulated areas), 850.27 (hygiene facilities and practices), 850.28 (respiratory protection), 850.29 (protective clothing and equipment), and 850.38 (warning signs) of this part.
	DOE O 440.1A	Exposure limits in applicable regulations take precedence over exposure limits adopted by Order; therefore, O 440.1A, paragraph 4.1(1) is not applicable to beryllium.
	DOE G 440.1-3	Action levels in applicable regulations take precedence over similar levels recommended in Guides; therefore, the G 440.1-3 section on Administrative Control Limits is not applicable to beryllium.

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4.2.4 Exposure Monitoring	10 CFR 850	<p>850. 24 Exposure monitoring.</p> <p>(a) <u>General</u>. The responsible employer must ensure that:</p> <p>(1) Exposure monitoring is managed by a qualified individual (e.g., a certified industrial hygienist); and</p> <p>(2) The individuals assigned to this task have sufficient industrial hygiene knowledge and experience to perform such activities properly.</p> <p>(b) <u>Initial monitoring</u>. The responsible employer must perform initial monitoring in areas that may have airborne beryllium, as shown by the baseline inventory and hazard assessment. The responsible employer must apply statistically-based monitoring strategies to obtain a sufficient number of sample results to adequately characterize exposures, before reducing or terminating monitoring.</p> <p>(1) The responsible employer must determine workers' 8-hour TWA exposure levels by conducting personal breathing zone sampling.</p> <p>(2) Exposure monitoring results obtained within the 12 months preceding the effective date of this part may be used to satisfy this requirement if the measurements were made as provided in paragraph (b)(1) of this section.</p> <p>(c) <u>Periodic exposure monitoring</u>. The responsible employer must conduct periodic monitoring of workers who work in areas where airborne concentrations of beryllium are at or above the action level. The monitoring must be conducted in a manner and at a frequency necessary to represent workers' exposure, as specified in the CBDPP. This periodic exposure monitoring must be performed at least every 3 months (quarterly).</p> <p>(d) <u>Additional exposure monitoring</u>. The responsible employer must perform additional monitoring if operations, maintenance or procedures change, or when the responsible employer has any reason to suspect such a change has occurred.</p>
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	10 CFR 850 (Cont.)	<p>(e) <u>Accuracy of monitoring</u>. The responsible employer must use a method of monitoring and analysis that has an accuracy of not less than plus or minus 25 percent, with a confidence level of 95 percent, for airborne concentrations of beryllium at the action level.</p> <p>(f) <u>Analysis</u>. The responsible employer must have all samples collected to satisfy the monitoring requirements of this part analyzed in a laboratory accredited for metals by the American Industrial Hygiene Association (AIHA) or a laboratory that demonstrates quality assurance for metals analysis that is equivalent to AIHA accreditation.</p> <p>(g) <u>Notification of monitoring results</u>.</p> <p>(1) The responsible employer must, within 10 working days after receipt of any monitoring results, notify the affected workers of monitoring results in writing. This notification of monitoring results must be:</p> <p>(i) Made personally to the affected worker; or</p> <p>(ii) Posted in location(s) that is readily accessible to the affected worker, but in a manner that does not identify the individual to other workers.</p> <p>(2) If the monitoring results indicate that a worker's exposure is at or above the action level, the responsible employer must include in the notice:</p> <p>(i) A statement that the action level has been met or exceeded; and</p> <p>(ii) A description of the corrective action being taken by the responsible employer to reduce the worker's exposure to below the action level, if practicable.</p> <p>(3) If the monitoring results indicate that worker exposure is at or above the action level, the responsible employer must also notify DOE and the SOMD of these results within 10 working days after receipt.</p>
	DOE O 440.1A	<p>4.i.(2): Assess worker exposure to chemical, physical, biological, or ergonomic hazards through appropriate workplace monitoring (including personal, area, wipe, and bulk sampling), biological monitoring, and observation. Monitoring results shall be recorded. Documentation shall describe the tasks and locations where monitoring occurred, identify workers monitored or represented by the monitoring, and identify the sampling methods and durations, control measures in place during monitoring (including the use of personal protective equipment), and any other factors that may have affected sampling results.</p> <p>Attachment 1, 5c: Periodic resurveys and/or exposure monitoring as appropriate.</p>
	DOE G 440.1-3	<p>4.2 through 4.5 contain guidance about exposure assessment approaches, conducting qualitative exposure assessments, and conducting quantitative exposure assessments.</p>

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4.2.5 Exposure Reduction and Minimization	10 CFR 850	<p>850. 25 Exposure reduction and minimization.</p> <p>(a) The responsible employer must ensure that no worker is exposed above the exposure limit prescribed in section 850.22.</p> <p>(b) The responsible employer must, in addition:</p> <p>(1) Where exposure levels are at or above the action level, establish a formal exposure reduction and minimization program to reduce exposure levels to below the action level, if practicable. This program must be described in the responsible employer's CBDPP and must include:</p> <p>(i) Annual goals for exposure reduction and minimization;</p> <p>(ii) A rationale for and a strategy for meeting the goals;</p> <p>(iii) Actions that will be taken to achieve the goals; and</p> <p>(iv) A means of tracking progress towards meeting the goals or demonstrating that the goals have been met.</p> <p>(2) Where exposure levels are below the action level, implement actions for reducing and minimizing exposures, if practicable. The responsible employer must include in the CBDPP a description of the steps to be taken for exposure reduction and minimization and a rationale for those steps.</p> <p>(c) The responsible employer must implement exposure reduction and minimization actions using the conventional hierarchy of industrial hygiene controls (i.e., engineering controls, administrative controls, and personal protective equipment in that order).</p>
	DOE O 440.1A	<p>4.j: Implement a hazard prevention/abatement process to ensure that all identified hazards are managed through final abatement or control.</p> <p>4.j(1): For hazards identified either in the facility design or during the development of procedures, controls are incorporated in the appropriate facility design or procedure.</p> <p>4.j(2): For existing hazards identified in the workplace, abatement actions prioritized according to risk to the worker are promptly implemented, interim protective measures are implemented pending final abatement, and workers are protected immediately from imminent danger conditions.</p> <p>4.j(3): Hazards are addressed when selecting or purchasing equipment, products, and services.</p> <p>4.j(4): Hazard control methods are selected based on the following hierarchy: (a) Engineering controls. (b) Work practices and administrative controls that limit worker exposures. (c) Personal protective equipment.</p>
	DOE O 440.1A (Cont.)	<p>Attachment 1, 5.b: . . . Industrial hygiene programs shall include . . . coordination with planning and design personnel to anticipate and control health hazards that proposed facilities and operations would introduce.</p> <p>Attachment 1, 5.e: Specification of appropriate engineering, administrative, work practice, and/or personal protective control methods to limit hazardous exposures to acceptable levels.</p>
	DOE G 440.1-1	<p>4.4 contains guidance for implementing a hazard prevention/abatement process to ensure that all identified hazards are managed through final abatement or control.</p>

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	DOE G 440.1-3	4.6.1.2 explains how exposure reduction goals for individuals and groups should be established and tracked for each significant risk group to help reduce exposures. It gives some suggested questions that should be considered in measuring management's performance in conducting exposure assessment.
4.2.6 Regulated Areas	10 CFR 850	850.26 Regulated areas. (a) If airborne concentrations of beryllium in areas in DOE facilities are measured at or above the action level, the responsible employer must establish regulated areas for those areas. (b) The responsible employer must demarcate regulated areas from the rest of the workplace in a manner that adequately alerts workers to the boundaries of such areas. (c) The responsible employer must limit access to regulated areas to authorized persons. (d) The responsible employer must keep records of all individuals who enter regulated areas. These records must include the name, date, time in and time out, and work activity.

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<p>4.2.7 Hygiene Facilities and Practices</p>	<p>10 CFR 850</p>	<p>850.27 Hygiene facilities and practices.</p> <p>(a) <u>General</u>. The responsible employer must assure that in areas where workers are exposed to beryllium at or above the action level, without regard to the use of respirators:</p> <ul style="list-style-type: none"> (1) Food or beverage and tobacco products are not used; (2) Cosmetics are not applied, except in change rooms or areas and shower facilities required under paragraphs (b) and (c) of this section; and (3) Beryllium workers are prevented from exiting areas that contain beryllium with contamination on their bodies or their personal clothing. <p>(b) <u>Change rooms or areas</u>. The responsible employer must provide clean change rooms or areas for beryllium workers who work in regulated areas.</p> <ul style="list-style-type: none"> (1) Separate facilities free of beryllium must be provided for beryllium workers to change into, and store, personal clothing, and clean protective clothing and equipment to prevent cross-contamination; and (2) The change rooms or areas that are used to remove beryllium-contaminated clothing and protective equipment must be maintained under negative pressure or located so as to minimize dispersion of beryllium into clean areas. <p>(c) <u>Showers and handwashing facilities</u>. (1) The responsible employer must provide handwashing and shower facilities for beryllium workers who work in regulated areas.</p> <ul style="list-style-type: none"> (2) The responsible employer must assure that beryllium workers who work in regulated areas shower at the end of the work shift. <p>(d) <u>Lunchroom facilities</u>. (1) The responsible employer must provide lunchroom facilities that are readily accessible to beryllium workers, and ensure that tables for eating are free of beryllium, and that no worker in a lunchroom facility is exposed at any time to beryllium at or above the action level.</p> <ul style="list-style-type: none"> (2) The responsible employer must assure that beryllium workers do not enter lunchroom facilities with protective work clothing or equipment unless the surface beryllium has been removed from clothing and equipment by HEPA vacuuming or other method that removes beryllium without dispersing it. <p>(e) The change rooms or areas, shower and handwashing facilities, and lunchroom facilities must comply with 29 CFR 1910.141, Sanitation.</p>
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4.2.8 Respiratory Protection	10 CFR 850	<p>850.28 Respiratory protection.</p> <p>(a) The responsible employer must establish a respiratory protection program that complies with the respiratory protection program requirements of 29 CFR 1910.134, Respiratory Protection.</p> <p>(b) The responsible employer must provide respirators to, and ensure that they are used by, all workers who:</p> <p>(1) Are exposed to an airborne concentration of beryllium at or above the action level, or</p> <p>(2) Are performing tasks for which analyses indicate the potential for exposures at or above the action level.</p> <p>(c) The responsible employer must include in the respiratory protection program any beryllium-associated worker who requests to use a respirator for protection against airborne beryllium, regardless of measured exposure levels.</p> <p>(d) The responsible employer must select for use by workers:</p> <p>(1) Respirators approved by the National Institute for Occupational Safety and Health (NIOSH) if NIOSH-approved respirators exist for a specific DOE task; or</p> <p>(2) Respirators that DOE has accepted under the DOE Respiratory Protection Acceptance Program if NIOSH-approved respirators do not exist for specific DOE tasks.</p>
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<p>4.2.9 Protective Clothing and Equipment</p>	<p>10 CFR 850</p>	<p>850.29 Protective clothing and equipment.</p> <p>(a) The responsible employer must provide protective clothing and equipment to beryllium workers and ensure its appropriate use and maintenance, where dispersible forms of beryllium may contact worker's skin, enter openings in workers' skin, or contact workers' eyes, including where:</p> <p>(1) Exposure monitoring has established that airborne concentrations of beryllium are at or above the action level; or</p> <p>(2) Surface contamination levels measured or presumed prior to initiating work are above the level prescribed in section 850.30; or</p> <p>(3) Surface contamination levels results obtained to confirm housekeeping efforts are above the level prescribed in section 850.30.</p> <p>(4) Any beryllium-associated worker who requests the use of protective clothing and equipment for protection against airborne beryllium, regardless of measured exposure levels.</p> <p>(b) The responsible employer must comply with 29 CFR 1910.132, Personal Protective Equipment General Requirements, when workers use personal protective clothing and equipment.</p> <p>(c) The responsible employer must establish procedures for donning, doffing, handling, and storing protective clothing and equipment that:</p> <p>(1) Prevent beryllium workers from exiting areas that contain beryllium with contamination on their bodies or their personal clothing; and</p> <p>(2) Include beryllium workers exchanging their personal clothing for full-body protective clothing and footwear before they begin work in regulated areas.</p> <p>(d) The responsible employer must ensure that no worker removes beryllium-contaminated protective clothing and equipment from areas that contain beryllium, except for workers authorized to launder, clean, maintain, or dispose of the clothing and equipment.</p> <p>(e) The responsible employer must prohibit the removal of beryllium from protective clothing and equipment by blowing, shaking, or other means that may disperse beryllium into the air.</p> <p>(f) The responsible employer must ensure that protective clothing and equipment is cleaned, laundered, repaired, or replaced as needed to maintain effectiveness. The responsible employer must:</p> <p>(1) Ensure that beryllium-contaminated protective clothing and equipment, when removed for laundering, cleaning, maintenance, or disposal, is placed in containers that prevent the dispersion of beryllium dust and that are labeled in accordance with section 850.38 of this part; and</p> <p>(2) Inform organizations that launder or clean DOE beryllium-contaminated protective clothing or equipment that exposure to beryllium is potentially harmful, and that clothing and equipment should be laundered or cleaned in a manner prescribed by the responsible employer to prevent the release of airborne beryllium.</p>
	<p>DOE O 440.1A</p>	<p>4.j(4)(c): Personal protective equipment. 4.l(3): Comply with . . . American National Standards Institute Z88.2, "Practices for Respiratory Protection."</p>

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	DOE G 440.1-1	<p>4.4.4.3: When engineering and/or administrative controls have been considered and implemented and are not sufficient to fully protect the worker from a recognized hazard, personal protective equipment can be used to supplement these other controls as appropriate. PPE is acceptable as a control method: to supplement engineering, work practice, or administrative controls when such controls are not feasible or do not adequately reduce the hazard; as an interim measure while engineering controls are being developed and implemented; during emergencies when engineering controls may not be feasible; and during maintenance and other non-routine activities where other controls are not feasible. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. An example would be a worker wearing several layers of clothing (for warmth and anti-contamination), a respirator, gloves, and a helmet while welding or cutting. This arrangement of PPE could prevent the worker from being aware of the environment in the event of a fire or other emergency. Research has also confirmed that fabric assemblies with high percentages of cotton fiber in their outer wear and/or underwear layers and no air space between layers yielded the highest maximum heat transfer rate and total heat transfer. These assemblies have more burn potential than assemblies containing higher amounts of polyester and more space between layers. In these situations, engineering and/or administrative controls (e.g., a fire watch to ensure the safety of the worker as well as the property) should be implemented to supplement PPE. Equipment and clothing should be selected that provide an adequate level of protection. The selection process should involve representatives of the affected safety disciplines (e.g., health physicist, industrial hygienist, fire protection staff, etc.) working in concert. Two basic objectives of any PPE practice should be to protect the wearer from safety and health hazards, and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To accomplish these objectives, a comprehensive PPE practice should include hazard identification (hazards that PPE will protect against and hazards caused by the use of PPE), medical monitoring, environmental surveillance, selection, use, maintenance, and decontamination of PPE and its associated training.</p>
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4.2.10 Housekeeping	10 CFR 850	<p>850.30 Housekeeping.</p> <p>(a) Where beryllium is present in operational areas of DOE facilities, the responsible employer must conduct routine surface sampling to determine housekeeping conditions. Surfaces contaminated with beryllium dusts and waste must not exceed a removable contamination level of 3 $\mu\text{g}/100\text{ cm}^2$ during non-operational periods. This sampling would not include the interior of installed closed systems such as enclosures, glove boxes, chambers, or ventilation systems.</p> <p>(b) When cleaning floors and surfaces in areas where beryllium is present at DOE facilities, the responsible employer must clean beryllium-contaminated floors and surfaces using a wet method, vacuuming or other cleaning methods, such as sticky tack cloths, that avoid the production of airborne dust. Compressed air or dry methods must not be used for such cleaning.</p> <p>(c) The responsible employer must equip the portable or mobile vacuum units that are used to clean beryllium-contaminated areas with HEPA filters, and change the filters as often as needed to maintain their capture efficiency.</p> <p>(d) The responsible employer must ensure that the cleaning equipment that is used to clean beryllium-contaminated surfaces is labeled, controlled, and not used for non-hazardous materials.</p>
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4.2.11 Release Criteria	10 CFR 850	<p>850.31 Release Criteria</p> <p>(a) The responsible employer must clean beryllium-contaminated equipment and other items to the lowest contamination level practicable, but not to exceed the levels established in paragraphs (b) and (c) of this section, and label the equipment or other items, before releasing them to the general public or a DOE facility for non-beryllium use, or to another facility for work involving beryllium.</p> <p>(b) Before releasing beryllium-contaminated equipment or other items to the general public or for use in a non-beryllium area of a DOE facility, the responsible employer must ensure that:</p> <p>(1) The removable contamination level of equipment or item surfaces does not exceed the higher of 0.2 Fg/100 cm² or the concentration level of beryllium in soil at the point of release, whichever is greater;</p> <p>(2) The equipment or item is labeled in accordance with section 850.38(b); and</p> <p>(3) The release is conditioned on the recipient's commitment to implement controls that will prevent foreseeable beryllium exposure, considering the nature of the equipment or item and its future use and the nature of the beryllium contamination.</p> <p>(c) Before releasing beryllium-contaminated equipment or other items to another facility performing work with beryllium, the responsible employer must ensure that:</p> <p>(1) The removable contamination level of equipment or item surfaces does not exceed 3 Fg/100 cm²;</p> <p>(2) The equipment or item is labeled in accordance with section 850.38(b); and</p> <p>(3) The equipment or item is enclosed or placed in sealed, impermeable bags or containers to prevent the release of beryllium dust during handling and transportation.</p>
4.2.12 Waste Disposal	10 CFR 850	<p>850.32 Waste disposal.</p> <p>(a) The responsible employer must control the generation of beryllium-containing waste, and beryllium-contaminated equipment and other items that are disposed of as waste, through the application of waste minimization principles.</p> <p>(b) Beryllium-containing waste, and beryllium-contaminated equipment and other items that are disposed of as waste, must be disposed of in sealed, impermeable bags, containers, or enclosures to prevent the release of beryllium dust during handling and transportation. The bags, containers, and enclosures that are used for disposal of beryllium waste must be labeled according to section 850.38.</p>
4.2.13 Beryllium Emergencies	10 CFR 850	<p>850.33 Beryllium emergencies.</p> <p>(a) The responsible employer must comply with 29 CFR 1910.120(l) for handling beryllium emergencies related to decontamination and decommissioning operations.</p> <p>(b) The responsible employer must comply with 29 CFR 1910.120(q) for handling beryllium emergencies related to all other operations.</p>

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4.2.14 Medical Surveillance	10 CFR 850	<p>850.34 Medical surveillance.</p> <p>(a) <u>General.</u></p> <p>(1) The responsible employer must establish and implement a medical surveillance program for all beryllium-associated workers who voluntarily participate in the program;</p> <p>(2) The responsible employer must designate a Site Occupational Medical Director (SOMD) who is responsible for administering the medical surveillance program.</p> <p>(3) The responsible employer must ensure that the medical evaluations and procedures required by this section are performed by, or under the supervision of, a licensed physician who is familiar with the health effects of beryllium.</p> <p>(4) The responsible employer must establish, and maintain, a list of beryllium-associated workers who may be eligible for protective measures under this part. The list must be:</p> <p>(i) Based on the hazard assessment, exposure records, and other information regarding the identity of beryllium-associated workers; and</p> <p>(ii) Adjusted at regular intervals based on periodic evaluations of beryllium-associated workers performed under paragraph (b)(2) of this section;</p>
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	10 CFR 850 (Cont.)	<p>(5) The responsible employer must provide the SOMD with the information needed to operate and administer the medical surveillance program, including the:</p> <ul style="list-style-type: none"> (i) List of beryllium-associated workers required by paragraph (a)(4) of this section; (ii) Baseline inventory; (iii) Hazard assessment and exposure monitoring data; (iv) Identity and nature of activities or operations on the site that are covered under the CBDPP, related duties of beryllium-associated workers; and (v) Type of personal protective equipment used. <p>(6) The responsible employer must provide the following information to the SOMD and the examining physician:</p> <ul style="list-style-type: none"> (i) A copy of this rule and its preamble; (ii) A description of the worker's duties as they pertain to beryllium exposure; (iii) Records of the worker's beryllium exposure; and (iv) A description of the personal protective and respiratory protective equipment used by the worker in the past, present, or anticipated future use. <p>(b) <u>Medical evaluations and procedures</u>. The responsible employer must provide, to beryllium-associated workers who voluntarily participate in the medical surveillance program, the medical evaluations and procedures required by this section at no cost and at a time and place that is reasonable and convenient to the worker.</p> <p>(1) <u>Baseline medical evaluation</u>. The responsible employer must provide a baseline medical evaluation to beryllium-associated workers. This evaluation must include:</p> <ul style="list-style-type: none"> (i) A detailed medical and work history with emphasis on past, present, and anticipated future exposure to beryllium; (ii) A respiratory symptoms questionnaire; (iii) A physical examination with special emphasis on the respiratory system, skin and eyes; (iv) A chest radiograph (posterior-anterior, 14 x 17 inches) interpreted by a National Institute for Occupational Safety and Health (NIOSH) B-reader of pneumoconiosis or a board-certified radiologist (unless a baseline chest radiograph is already on file); (v) Spirometry consisting of forced vital capacity (FVC) and forced expiratory volume at 1 second (FEV1); (vi) A Be-LPT; and (vii) Any other tests deemed appropriate by the examining physician for evaluating beryllium-related health effects.
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	<p>10 CFR 850 (Cont.)</p>	<p>(2) <u>Periodic evaluation</u>. (i) The responsible employer must provide to beryllium workers a medical evaluation annually, and to other beryllium-associated workers a medical evaluation every three years. The periodic medical evaluation must include:</p> <ul style="list-style-type: none"> (A) A detailed medical and work history with emphasis on past, present, and anticipated future exposure to beryllium; (B) A respiratory symptoms questionnaire; (C) A physical examination with emphasis on the respiratory system; (D) A Be-LPT; and (E) Any other medical evaluations deemed appropriate by the examining physician for evaluating beryllium-related health effects. <p>(ii) The responsible employer must provide to beryllium-associated workers a chest radiograph every five years.</p> <p>(3) <u>Emergency evaluation</u>. The responsible employer must provide a medical evaluation as soon as possible to any worker who may have been exposed to beryllium because of a beryllium emergency. The medical evaluation must include the requirements of paragraph (b)(2) of this section.</p> <p>(c) <u>Multiple physician review</u>. The responsible employer must establish a multiple physician review process for beryllium-associated workers that allows for the review of initial medical findings, determinations, or recommendations from any medical evaluation conducted pursuant to subsection (b) of this section.</p> <p>(1) If the responsible employer selects the initial physician to conduct any medical examination or consultation provided to a beryllium-associated worker, the worker may designate a second physician to:</p> <ul style="list-style-type: none"> (i) Review any findings, determinations, or recommendations of the initial physician; and (ii) Conduct such examinations, consultations and laboratory tests, as the second physician deems necessary to facilitate this review. <p>(2) The responsible employer must promptly notify a beryllium-associated worker in writing of the right to seek a second medical opinion after the initial physician provided by the responsible employer conducts a medical examination or consultation.</p> <p>(3) The responsible employer may condition its participation in, and payment for, multiple physician review upon the beryllium-associated worker doing the following within fifteen (15) days after receipt of the notice, or receipt of the initial physician's written opinion, whichever is later:</p> <ul style="list-style-type: none"> (i) Informing the responsible employer in writing that he or she intends to seek a second medical opinion; and (ii) Initiating steps to make an appointment with a second physician.
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	10 CFR 850 (Cont.)	<p>(4) If the findings, determinations, or recommendations of the second physician differ from those of the initial physician, then the responsible employer and the beryllium-associated worker must make efforts to encourage and assist the two physicians to resolve any disagreement.</p> <p>(5) If, despite the efforts of the responsible employer and the beryllium-associated worker, the two physicians are unable to resolve their disagreement, then the responsible employer and the worker, through their respective physicians, must designate a third physician to:</p> <p>(i) Review any findings, determinations, or recommendations of the other two physicians; and</p> <p>(ii) Conduct such examinations, consultations, laboratory tests, and consultations with the other two physicians, as the third physician deems necessary to resolve the disagreement among them.</p> <p>(6) The SOMD must act consistently with the findings, determinations, and recommendations of the third physician, unless the SOMD and the beryllium-associated worker reach an agreement that is consistent with the recommendations of at least one of the other two physicians.</p> <p>(d) <u>Alternate physician determination</u>. The responsible employer and the beryllium-associated worker or the worker's designated representative may agree upon the use of any alternate form of physician determination in lieu of the multiple physician review process provided by paragraph (c) of this section, so long as the alternative is expeditious and at least as protective of the worker.</p> <p>(e) <u>Written medical opinion and recommendation</u>. (1) Within two weeks of receipt of results, the SOMD must provide to the responsible employer a written, signed medical opinion for each medical evaluation performed on each beryllium-associated worker. The written opinion must take into account the findings, determinations, and recommendations of the other examining physicians who may have examined the beryllium-associated worker. The SOMD's opinion must contain:</p> <p>(i) The diagnosis of the worker's condition relevant to occupational exposure to beryllium, and any other medical condition that would place the worker at increased risk of material impairment to health from further exposure to beryllium;</p> <p>(ii) Any recommendation for removal of the worker from DOE beryllium activities, or limitation on the worker's activities or duties or use of personal protective equipment, such as a respirator; and</p>
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		<p>(iii) A statement that the SOMD or examining physician has clearly explained to the worker the results of the medical evaluation, including all tests results and any medical condition related to beryllium exposure that requires further evaluation or treatment.</p> <p>(2) The SOMD's written medical opinion must not reveal specific records, findings, and diagnoses that are not related to medical conditions that may be affected by beryllium exposure.</p> <p>(f) <u>Information provided to the beryllium-associated worker.</u> (1) The SOMD must provide each beryllium-associated worker with a written medical opinion containing the results of all medical tests or procedures, an explanation of any abnormal findings, and any recommendation that the worker be referred for additional testing for evidence of CBD, within 10 working days after the SOMD's receipt of the results of the medical tests or procedures.</p> <p>(2) The responsible employer must, within 30 days after a request by a beryllium-associated worker, provide the worker with the information the responsible employer is required to provide the examining physician under paragraph (a)(6) of this section.</p> <p>(g) <u>Reporting.</u> The responsible employer must report on the applicable OSHA reporting form beryllium sensitization, CBD, or any other abnormal condition or disorder of workers caused or aggravated by occupational exposure to beryllium.</p> <p>(h) <u>Data analysis.</u> (1) The responsible employer must routinely and systematically analyze medical, job, and exposure data with the aim of identifying individuals or groups of individuals potentially at risk for CBD and working conditions that are contributing to that risk.</p> <p>(2) The responsible employer must use the results of these analyses to identify additional workers to whom the responsible employer must provide medical surveillance and to determine the need for additional exposure controls.</p>
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	DOE O 440.1A	<p>Attachment 2, 18.c(1)(c)-(e): Occupational medical physicians and selected medical staff shall: . . . perform targeted examinations based on an up-to-date knowledge of work site risk,. . . (d) identify potential or actual health effects resulting from work site exposures, and (e) communicate the results of health evaluations to management and to those responsible for mitigating work site hazards.</p> <p>Attachment 2, 18.d(1): Health examinations shall be conducted by an occupational health examiner under the direction of a licensed physician in accordance with current sound and acceptable medical practices.</p> <p>Attachment 2, 18.d(2): The content of health examinations shall be the responsibility of the physician responsible for delivery of medical services.</p> <p>Attachment 2, 18.d(3)(d): The following classes of examinations are required . . . medical surveillance and health monitoring.</p> <p>Attachment 2, 18.d(4): The occupational medical department shall be informed of all job transfers and shall determine whether a medical evaluation is necessary.</p> <p>Attachment 2, 18.e(1): The occupational medical program shall be responsible for the review of all monitored care of ill and injured employees to maximize their recovery and safe return to work, and to minimize lost time and its associated costs.</p> <p>Attachment 2, 18.g(1)-(3): An employee medical record shall be developed and maintained for each employee for which medical services are provided. The confidentiality of all employee medical records shall be observed. Employee medical records shall be adequately protected and stored permanently.</p>
	DOE G 440.1-3	4.6.2 discusses the role of exposure assessment in occupational medicine and medical monitoring.

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	DOE G 440.1-4	<p>4: (This section contains guidelines for an occupational medical program, including implementation of an onsite program, maintenance of a healthful work environment, employee health evaluations, diagnosis and treatment of injury or disease, medical records, organization, staffing, facilities, and equipment.)</p> <p>4.3.2: The medical professional responsible for the occupational medical program should have responsibility for health evaluation content. Initial or baseline evaluations should be comprehensive, and follow-up evaluations should be additionally targeted as determined by employee exposure data, job task and hazard analysis information, or other occupationally related factors. Minimum elements of a comprehensive evaluation are: medical/occupational history, physical examination, laboratory studies, and review and evaluation of findings. The protocols for x-ray examinations should follow the recommendations and guidance contained in 43 FR 4377, dated 2-1-78. All radiographs should be interpreted by a qualified radiologist or as specified by OSHA/DOE.</p> <p>4.3.3.2: Standards and requirements for special health evaluations and health monitoring of employees who work in jobs involving specific physical, chemical, or biological hazards should be in accordance with applicable OSHA/DOE standards. When employees are exposed to potential hazards not covered by regulations, appropriate special evaluations may be required as determined by the physician responsible for medical services and approved by the DOE Director, Office of Occupational Medicine and Medical Surveillance.</p> <p>4.3.3.5: All employees with occupationally related injuries or illnesses should be evaluated before returning to work. The scope and content of this evaluation should be determined by the OHE, based upon the nature and extent of the injury or disease, and should be sufficient to ensure that the employee may return to work without undue health risk to self or others. The employee should obtain written clearance from the occupational medical department before returning to work.</p> <p>4.4.1: The management of occupational injury or disease should be in accordance with the laws and regulations of the state in which the facility is located. Diagnosis and treatment of occupational injury or disease should be prompt, with emphasis placed on rehabilitation and return to work at the earliest time compatible with job safety and employee health. Contractor management has the responsibility to establish procedures to ensure that all employees with occupational injuries or illnesses receive medical clearance before returning to work. The responsible first-line management and health and safety groups (health physics, industrial hygiene, or safety) should be notified of unhealthy work situations detected by the occupational medical staff.</p>
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<p>4.2.15 Medical Removal</p>	<p>10 CFR 850</p>	<p>850.35 Medical removal.</p> <p>(a) <u>Medical removal protection.</u> The responsible employer must offer a beryllium-associated worker medical removal from exposure to beryllium if the SOMD determines in a written medical opinion that it is medically appropriate to remove the worker from such exposure. The SOMD's determination must be based on one or more positive Be-LPT results, chronic beryllium disease diagnosis, an examining physician's recommendation, or any other signs or symptoms that the SOMD deems medically sufficient to remove a worker.</p> <p>(1) <u>Temporary removal pending final medical determination.</u> The responsible employer must offer a beryllium-associated worker temporary medical removal from exposure to beryllium on each occasion that the SOMD determines in a written medical opinion that the worker should be temporarily removed from such exposure pending a final medical determination of whether the worker should be removed permanently.</p> <p>(i) In this section, "final medical determination" means the outcome of the multiple physician review process or the alternate medical determination process provided for in paragraphs (c) and (d) of section 850.34.</p> <p>(ii) If a beryllium-associated worker is temporarily removed from beryllium exposure pursuant to this section, the responsible employer must transfer the worker to a comparable job for which the worker is qualified (or for which the worker can be trained in a short period) and where beryllium exposures are as low as possible, but in no event at or above the action level.</p> <p>(iii) The responsible employer must maintain the beryllium-associated worker's total normal earnings, seniority, and other worker rights and benefits as if the worker had not been removed.</p> <p>(iv) If there is no such job available, the responsible employer must provide to the beryllium-associated worker the medical removal protection benefits specified in paragraph (b)(2) of this section, until a job becomes available or for one year, whichever comes first.</p>
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	<p>10 CFR 850 (Cont.)</p>	<p>(2) <u>Permanent medical removal.</u> (i) The responsible employer must offer a beryllium-associated worker permanent medical removal from exposure to beryllium if the SOMD determines in a written medical opinion that the worker should be permanently removed from exposure to beryllium.</p> <p>(ii) If a beryllium-associated worker is removed permanently from beryllium exposure based on the SOMD's recommendation pursuant to this section, the responsible employer must provide the worker the medical removal protection benefits specified in paragraph (b) of this section.</p> <p>(3) <u>Worker consultation before temporary or permanent medical removal.</u> If the SOMD determines that a beryllium-associated worker should be temporarily or permanently removed from exposure to beryllium, the SOMD must:</p> <p>(i) Advise the beryllium-associated worker of the determination that medical removal is necessary to protect the worker's health;</p> <p>(ii) Provide the beryllium-associated worker with a copy of this rule and its preamble, and any other information the SOMD deems necessary on the risks of continued exposure to beryllium and the benefits of removal;</p> <p>(iii) Provide the beryllium-associated worker the opportunity to have any questions concerning medical removal answered; and</p> <p>(iv) Obtain the beryllium-associated worker's signature acknowledging that the worker has been advised to accept medical removal from beryllium exposure as provided in this section, and has been provided with the information specified in this paragraph, on the benefits of removal and the risks of continued exposure to beryllium.</p> <p>(4) <u>Return to work after medical removal.</u> (i) The responsible employer, subject to subparagraph (ii) of this paragraph, must not return a beryllium-associated worker who has been permanently removed under this section to the worker's former job status unless the SOMD first determines in a written medical opinion that continued medical removal is no longer necessary to protect the worker's health.</p> <p>(ii) Notwithstanding subparagraph (i) of this paragraph, if, in the SOMD's opinion, continued exposure to beryllium will not pose an increased risk to the beryllium-associated worker's health, and medical removal is an inappropriate remedy in the circumstances, the SOMD must fully discuss these matters with the worker and the, in a written, determination, may authorize the responsible employer to return the worker to his or her former job status. Thereafter, the returned beryllium-associated worker must continue to be provided with medical surveillance under section 850.34 of this part.</p>
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	10 CFR 850 (Cont.)	<p>(b) <u>Medical removal protection benefits</u>. (1) If a beryllium-associated worker has been permanently removed from beryllium exposure pursuant to paragraph (a)(2) of this section, the responsible employer must provide the beryllium-associated worker:</p> <p>(i) The opportunity to transfer to another position which is available, or later becomes available, for which the beryllium-associated worker is qualified (or for which the worker can be trained in a short period) and where beryllium exposures are as low as possible, but in no event at or above the action level; or</p> <p>(ii) If the beryllium-associated worker cannot be transferred to a comparable job where beryllium exposures are below the action level, a maximum of 2 years of permanent medical removal protection benefits (specified in paragraph (b)(2) of this section).</p> <p>(2) If required by this section to provide medical removal protection benefits, the responsible employer must maintain the removed worker's total normal earnings, seniority and other worker rights and benefits, as though the worker had not been removed.</p> <p>(3) If a removed beryllium-associated worker files a claim for workers' compensation payments for a beryllium-related disability, then the responsible employer must continue to provide medical removal protection benefits pending disposition of the claim. The responsible employer must receive no credit for the workers' compensation payments received by the worker for treatment related expenses.</p> <p>(4) The responsible employer's obligation to provide medical removal protection benefits to a removed beryllium-associated worker is reduced to the extent that the worker receives compensation for earnings lost during the period of removal either from a publicly- or employer-funded compensation program, or from employment with another employer made possible by virtue of the worker's removal.</p> <p>(5) For the purposes of this section, the requirement that a responsible employer provide medical removal protection benefits is not intended to expand upon, restrict, or change any rights to a specific job classification or position under the terms of an applicable collective bargaining agreement.</p> <p>(6) The responsible employer may condition the provision of medical removal protection benefits upon the beryllium-associated worker's participation in medical surveillance provided in accordance with § 850.34 of this part.</p>
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4.2.16 Medical Consent	10 CFR 850	<p>850.36 Medical consent.</p> <p>(a) The responsible employer must provide each beryllium-associated worker with a summary of the medical surveillance program established in section 850.34 at least one week before the first medical evaluation or procedure or at any time requested by the worker. This summary must include:</p> <p>(1) The type of data that will be collected in the medical surveillance program;</p> <p>(2) How the data will be collected and maintained;</p> <p>(3) The purpose for which the data will be used; and</p> <p>(4) A description of how confidential data will be protected.</p> <p>(b) Responsible employers must also provide each beryllium-associated worker with information on the benefits and risks of the medical tests and examinations available to the worker at least one week prior to any such examination or test, and an opportunity to have the worker's questions answered.</p> <p>(c) The responsible employer must have the SOMD obtain a beryllium-associated worker's signature on an informed consent form found in Appendix A to this part, before performing medical evaluations or any tests.</p>
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4.2.17 Training and Counseling	10 CFR 850	<p>850.37 Training and counseling.</p> <p>(a) The responsible employer must develop and implement a beryllium training program and ensure participation for:</p> <ol style="list-style-type: none"> (1) Beryllium-associated workers; and (2) All other individuals who work at a site where beryllium activities are conducted. <p>(b) The training provided for workers identified in paragraph (a)(1) of this section, must:</p> <ol style="list-style-type: none"> (1) Be in accordance with 29 CFR 1910.1200, Hazard Communication; (2) Include the contents of the CBDPP; and (3) Include potential health risks to beryllium worker family members and others who may come in contact with beryllium on beryllium workers or beryllium workers' personal clothing or other personal items as the result of a beryllium control failure at a DOE facility. <p>(c) The training provided for workers identified in paragraph (a)(2) of this section must consist of general awareness about beryllium hazards and controls.</p> <p>(d) The responsible employer must provide the training required by this section before or at the time of initial assignment and at least every two years thereafter.</p> <p>(e) The employer must provide retraining when the employer has reason to believe that a beryllium worker lacks the proficiency, knowledge, or understanding needed to work safely with beryllium, including at least the following situations:</p> <ol style="list-style-type: none"> (1) To address any new beryllium hazards resulting from a change to operations, procedures, or beryllium controls about which the beryllium worker was not previously trained; and (2) If a beryllium worker's performance involving beryllium work indicates that the worker has not retained the requisite proficiency.
	10 CFR 850 (Cont.)	<p>(f) The responsible employer must develop and implement a counseling program to assist beryllium-associated workers who are diagnosed by the SOMD to be sensitized to beryllium or to have CBD. This counseling program must include communicating with beryllium-associated workers concerning:</p> <ol style="list-style-type: none"> (1) The medical surveillance program provisions and procedures; (2) Medical treatment options; (3) Medical, psychological, and career counseling; (4) Medical benefits; (5) Administrative procedures and workers rights under applicable Workers' Compensation laws and regulations; (6) Work practice procedures limiting beryllium-associated worker exposure to beryllium; and (7) The risk of continued beryllium exposure after sensitization.
	DOE O 440.1A	<p>4.k: Provide workers, supervisors, managers, visitors, and worker protection professionals with worker protection training.</p> <p>Attachment 1, 5.f: Industrial hygiene programs shall include the following elements: . . . Worker education, training, and involvement.</p>

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	DOE G 440.1-1	4.5 contains guidance on providing worker protection training and refers to other training requirements in DOE O 360.1 and 29 CFR 1960, Subpart H.
4.2.18 Warning Signs and Labels	10 CFR 850	<p>850.38 Warning signs and labels.</p> <p>(a) Warning signs. The responsible employer must post warning signs at each access point to a regulated area with the following information:</p> <p style="text-align: center;">DANGER BERYLLIUM CAN CAUSE LUNG DAMAGE CANCER HAZARD AUTHORIZED PERSONNEL ONLY</p> <p>(b) Warning labels. (1) The responsible employer must affix warning labels to all containers of beryllium, beryllium compounds, or beryllium-contaminated clothing, equipment, waste, scrap, or debris.</p> <p>(2) Warning labels must contain the following information:</p> <p style="text-align: center;">DANGER CONTAMINATED WITH BERYLLIUM DO NOT REMOVE DUST BY BLOWING OR SHAKING CANCER AND LUNG DISEASE HAZARD</p> <p>(c) Warning signs and labels must be in accordance with 29 CFR 1910.1200, Hazard Communication.</p>

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4.2.19 Recordkeeping and Use of Information	10 CFR 850	<p>850. 39 Recordkeeping and use of information.</p> <p>(a) The responsible employer must establish and maintain accurate records of all beryllium inventory information, hazard assessments, exposure measurements, exposure controls, and medical surveillance.</p> <p>(b) Heads of DOE Departmental Elements must:</p> <p>(1) Designate all record series as required under this rule as agency records and, therefore, subject to all applicable agency records management and access laws; and</p> <p>(2) Ensure that these record series are retained for a minimum of seventy-five years.</p> <p>(c) The responsible employer must convey to DOE or its designee all record series required under this rule if the employer ceases to be involved in the CBDPP.</p> <p>(d) The responsible employer must link data on workplace conditions and health outcomes in order to establish a basis for understanding the beryllium health risk.</p> <p>(e) The responsible employer must ensure the confidentiality of all work-related records generated under this rule by ensuring that:</p> <p>(1) All records that are transmitted to other parties do not contain names, social security numbers or any other variables, or combination of variables, that could be used to identify particular individuals; and</p> <p>(2) Individual medical information generated by the CBDPP is:</p> <p>(i) Either included as part of the worker's site medical records and maintained by the SOMD, or is maintained by another physician designated by the responsible employer;</p> <p>(ii) Maintained separately from other records; and</p> <p>(iii) Used or disclosed by the responsible employer only in conformance with any applicable requirements imposed by the Americans with Disabilities Act, the Privacy Act of 1974, the Freedom of Information Act, and any other applicable law.</p>
		<p>(f) The responsible employer must maintain all records required by this part in current and accessible electronic systems which include the ability readily to retrieve data in a format that maintains confidentiality.</p> <p>(g) The responsible employer must transmit all records generated as required by this rule, in a format that protects the confidentiality of individuals, to the DOE Assistant Secretary for Environment, Safety and Health on request.</p> <p>(h) The responsible employer must semi-annually transmit to the DOE Office of Epidemiologic Studies within the Office of Environment, Safety and Health an electronic registry of beryllium-associated workers that protects confidentiality, and the registry must include, but is not limited to, a unique identifier, date of birth, gender, site, job history, medical screening test results, exposure measurements, and results of referrals for specialized medical evaluations.</p>
	DOE O 440.1A	4.i(4): Report and investigate accidents, injuries, and illnesses (reference DOE O 231.1, 232.1, and 225.1) and analyze related data for trends and lessons learned (reference DOE O 210.1).

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	DOE G 440.1-1	4.3.4 contains guidance on recordkeeping, reporting, and data analyses for accident, injuries, and illnesses.
4.2.20 Performance Feedback	10 CFR 850	<p>850.40 Performance feedback.</p> <p>(a) The responsible employer must conduct periodic analyses and assessments of monitoring activities, hazards, medical surveillance, exposure reduction and minimization, and occurrence reporting data.</p> <p>(b) To ensure that information is available to maintain and improve all elements of the CBDPP continuously, the responsible employer must give results of periodic analyses and assessments to the line managers, planners, worker protection staff, workers, medical staff, and labor organizations representing beryllium-associated workers who request such information.</p>
	DOE O 440.1A	<p>4.I(4): Report and investigate accidents, injuries, and illnesses (reference DOE O 231.1, 232.1, and 225.1) and analyze related data for trends and lessons learned (reference DOE O 210.1).</p> <p>Attachment 1, 5.g: Industrial hygiene programs shall include . . . coordination with cognizant occupational medical, environmental, health physics, and work planning professionals.</p> <p>Attachment 2, 18.c(1)(a),(e): Occupational medical physicians and selected medical staff shall: (a) coordinate with other safety and health professionals (industrial hygienists, health physicists, safety specialists/managers) to identify work-related or work site hazards and their possible health risks to employees, . . . (e) communicate the results of health evaluations to management and to those responsible for mitigating work site hazards.</p> <p>Attachment 2, 18.c(2)(a)-(c): Contractor management shall provide to the physician responsible for delivery of medical services: (a) employee job task and hazard analysis information; (b) summaries of potential work site exposures of employees prior to mandatory health examinations; and (c) the opportunity to participate in worker protection team meetings and committees.</p>
	DOE G 440.1-1	4.3.4 contains guidance on recordkeeping, reporting, and data analysis for accidents, injuries, and illnesses.

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Appendix B

STATISTICAL ANALYSIS OF BERYLLIUM EXPOSURE MONITORING RESULTS

An exposure monitoring and control strategy will depend in large part on the amount of variance in exposure levels. Analysis of the variance in exposures can help identify the important determinants to use in developing a monitoring and control strategy. In general, we find that exposures in even well-controlled beryllium activities will have more variance than is typical for occupational exposure data. Variance of beryllium exposure as measured by geometric standard deviation (GSD) has generally been greater than 3. This variance has primarily been within-worker variance or day-to-day variance, rather than between-worker variance. Within-worker variability would point to work practices as being an important determinant while between-worker variability would point to process equipment as being an important determinant.

Below are three example analyses of 8-Hr TWA beryllium exposure distributions. The first data set is made up of 529 breathing zone samples collected in a one month period in a Rocky Flats machine shop that fabricated beryllium metal parts. This shop had recently been associated with a high prevalence of chronic beryllium disease. It received a high level of industrial hygiene attention to both process controls and work practices leading to a more than 20 fold reduction in exposure levels. This is population data rather than a sample since each worker was monitored for each shift and there were no non-detected results. All distribution parameters are directly calculated. The geometric standard deviation for this group is 3.2. Notice that the arithmetic mean is about 3 times the geometric mean (and median.) This demonstrates the relatively large influence excursions are having on the arithmetic mean.

Descriptive Statistics

9/22-10/29/1986 Personal Breathing Zone Samples

Rocky Flats Beryllium Machine Shop

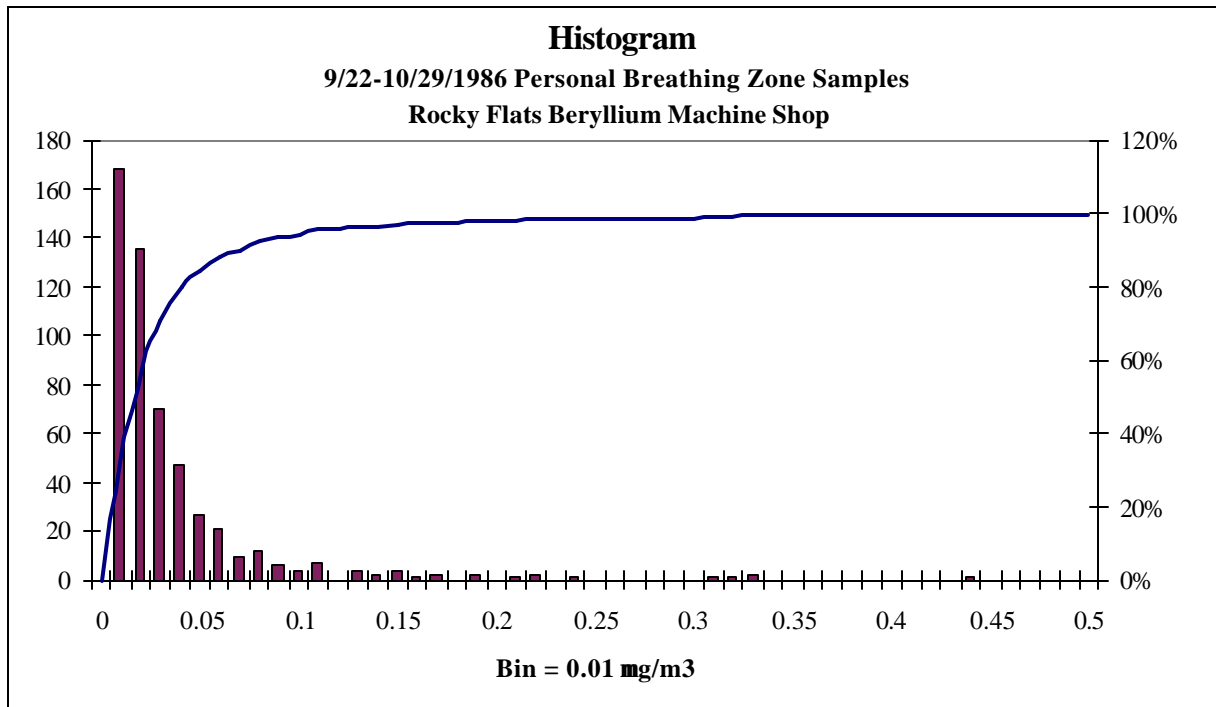
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Geometric Mean	0.016 $\mu\text{g}/\text{m}^3$
Geometric Standard Deviation	3.20
Arithmetic Mean	0.044 $\mu\text{g}/\text{m}^3$
Actual 95 th %	0.107 $\mu\text{g}/\text{m}^3$

Range of 8-Hr TWAs

<u>Rank</u>		<u>Result</u>
1	-	0.0001 $\mu\text{g}/\text{m}^3$
	...	
265	-	0.016 $\mu\text{g}/\text{m}^3$
	...	
529	-	5.58 $\mu\text{g}/\text{m}^3$

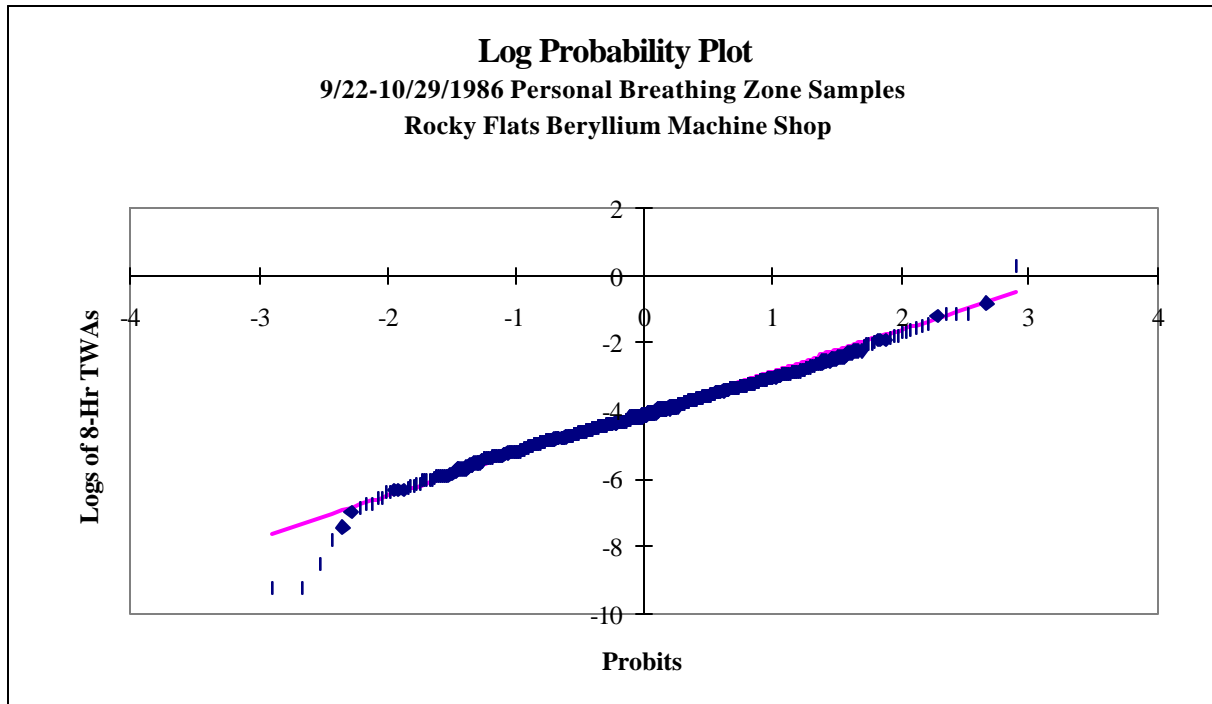
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On a linear scale you can see that the distribution of exposures is highly skewed.

The log transformed data appear to be normally distributed, justifying the use of log normal statistics.

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The group included 23 individuals who had between 12 and 28 measurements each. Below is an analysis of variance of log transformed data performed by Microsoft Excel (Tools, Data Analysis, ANOVA.) This is the method the AIHA strategy book (ref. 8) recommends using for the analysis of variance. Each "group" is the arbitrarily assigned ID number of an individual worker.

Anova: Single Factor

SUMMARY

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
10400	24	-79.9829	-3.33262	1.254854
12222	19	-68.6356	-3.6124	0.463363
12345	22	-106.445	-4.83841	0.514467
13333	20	-79.8691	-3.99346	0.699468
13456	17	-86.2928	-5.07604	1.312188
14444	24	-109.447	-4.56031	1.148093
14567	24	-76.1178	-3.17158	0.658827
15555	21	-84.6826	-4.0325	0.45387
15678	23	-121.068	-5.26382	1.263425
17890	24	-116.838	-4.86826	1.67401
18901	22	-74.5334	-3.38788	1.452094
19012	19	-84.1953	-4.43133	1.061457
22443	26	-105.691	-4.06503	1.393124
22451	23	-82.3002	-3.57827	0.588067
45491	24	-93.6838	-3.90349	1.161093
46979	20	-74.271	-3.71355	2.625731
50435	28	-129.372	-4.62042	0.326688
67709	28	-109.801	-3.92146	1.688668
76744	23	-102.826	-4.47069	1.544067
89177	28	-113.572	-4.05613	0.830275
95335	22	-86.5841	-3.93564	1.317352
99417	27	-93.7388	-3.47181	1.659504
516789	12	-43.327	-3.61058	0.39016

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	167.3707	22	7.607757	6.762879	8.17E-18	1.563627
Within Groups	559.0896	497	1.124929			

Two results are important. The F-Critical statistic is less then F showing that individuals do not have the same mean exposure levels and are not a homogeneous exposure group. Exposure measurements

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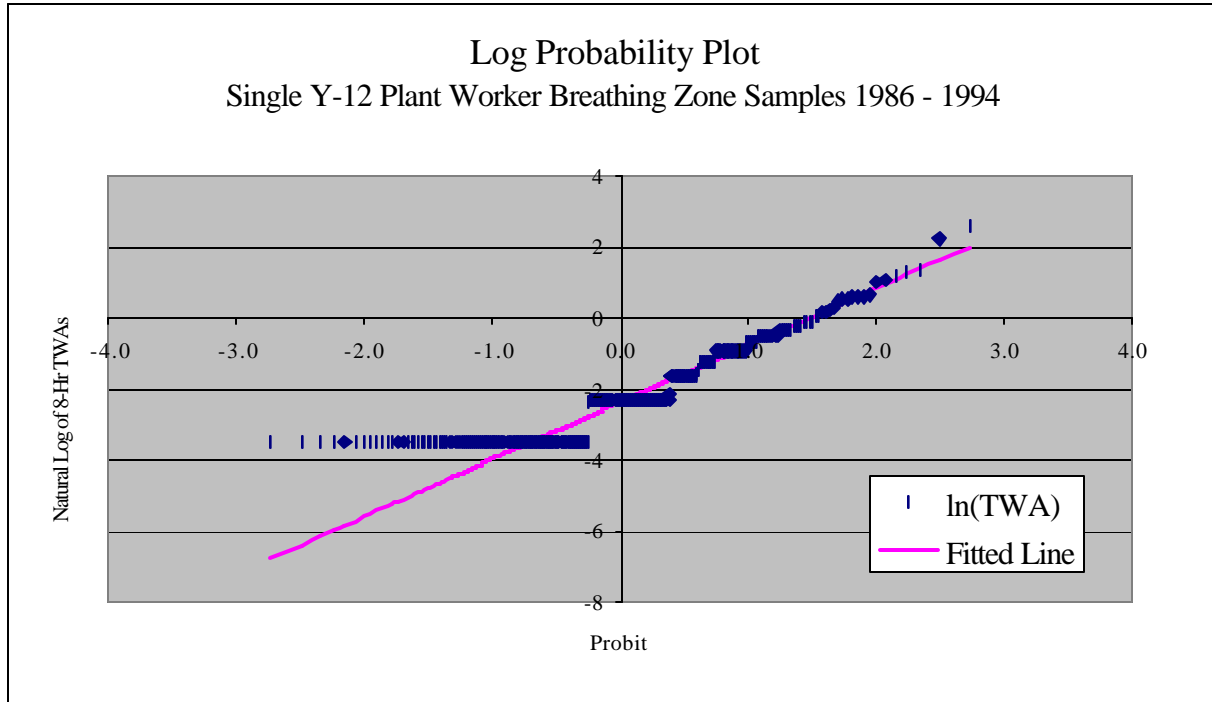
from one worker are not representative of the exposures of other members of the group. The sum of squares statistic for within worker variation is much larger than the same statistic for between worker variation. Despite the fact that this was a production operation, work practices rather than process variables are the most important exposure determinant. This is probably due to the successful control of leakage from process equipment, which minimized process variables as a determinant of exposure levels.

This underlying distribution of exposures indicates the need for a high frequency of exposure monitoring. The large GSD and separation of the arithmetic mean from the median indicates that monitoring must be oriented toward detecting the infrequent excursions that are responsible for much of the health risk associated with this operation. Measurements from one worker are not representative of others. Any further reduction of exposures will depend primarily on assuring that employees and their supervisors understand the work practices that are causing exposures. This requires monitoring data since we are operating in a realm where the senses are of little use in judging exposure potential.

A second example comes from the Oak Ridge Y-12 Plant. In this data set, not all shifts were monitored and a high percentage of monitoring results were non-detect. A few individuals were monitored frequently making it possible to estimate the degree of within-worker variance for them. Geometric mean and geometric standard deviation are estimated by using Microsoft Excel's regression function with the log transformed 8-Hr TWAs as the dependent variable and probits as the independent variable. Probits are the standard normal variable (z) calculated from the probability produced by dividing the rank order of the result by $n+1$. The Excel function NORMINV returns the probit that corresponds to the probability. The geometric mean is the exponent of the regression intercept and the geometric standard deviation is the exponent of the regression slope. The fitted line on the log probability plot is produced by multiplying the regression slope (X variable) times the probit plus the

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regression intercept. This computerizes the graphical method for estimating distribution parameters of censored data recommended in the AIHA's "Strategy" book (ref. 8).



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Distribution parameters are estimated based on the assumption that non-detected and non-measured 8-Hr TWAs would have also been log normal and fallen on the line fitted to the detected monitoring results. For this individual, 188 of 314 monitoring results were above the detection limit of $0.1 \mu\text{g}/\text{m}^3$. The regression output and estimated distribution parameters are as follows.

From the Excel regression function (Tools, Data Analysis, Regression)

Intercept -2.38
X Variable 1.61

<u>Estimated Distribution Parameters</u>		<u>Method of Calculating Estimate</u>
Geometric Mean	$0.09 \mu\text{g}/\text{m}^3$	By EXP of Regression Intercept
Geometric Standard Deviation	5.01	By EXP of Regression X Variable
Arithmetic Mean	$0.34 \mu\text{g}/\text{m}^3$	By $\text{EXP}(\ln \text{GM} + \frac{1}{2} (\ln \text{GSD})^2)$
95 th Percentile	$1.32 \mu\text{g}/\text{m}^3$	By $\text{EXP}(\ln \text{GM} + 1.645(\ln \text{GSD}))$
Z value of $2 \mu\text{g}/\text{m}^3$	1.91	By $Z = (\ln 2 - \ln \text{GM})/\ln \text{GSD}$
Percent less than $2 \mu\text{g}/\text{m}^3$	97%	By Excel NORMSDIST(Z)
95/95 Geometric Upper Tolerance Limit	$1.80 \mu\text{g}/\text{m}^3$	By $\text{EXP}(\ln \text{GM} + K (\ln \text{GSD}))$ Where $K = 1.84$

Range of 8-Hr TWAs

<u>Rank</u>	<u>Result</u>
1	$< 0.1 \mu\text{g}/\text{m}^3$ (Minimum)
...	

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127	0.1 µg/m ³ (First Detectable Result)
...	
157	0.1 µg/m ³ (Median)
158	0.1 µg/m ³ (Median)
...	
314	13.6µg/m ³ (Maximum)

The Microsoft Excel ANOVA function can not be used on highly censored data. If fewer than 10% of samples are below the detection limit, then substituting 2/3 the detection limit for the non-detected result has been recommended as an effective method of developing estimates and this would allow the use of the ANOVA function. Alternate and fairly simple methods of analysis are discussed Patty's Industrial Hygiene and Toxicology (see Rappaport, S.M. "Interpreting Levels of Exposures to Chemical Agents" in Patty's Industrial Hygiene and Toxicology, Vol. III, Part A, 3rd Edition; Harris, Cralley, and Cralley Eds, pages 349 - 404.) The GSD of the arithmetic mean exposure level of members of a group provides a measure of between worker variability while the GSD of individuals exposure levels is a measure of within worker variability. A group is considered to homogeneous if the 95% of individual mean exposure levels are within a factor of 4.

$$97.5\% \text{ mean} / 2.5\% \text{ mean} < 4$$

Three other workers in the Y-12 Plant data set had large enough numbers of detected exposure monitoring results to estimate exposure parameters.

Rank	ln(mean)	Total	Detectable	GM	GSD	Mean
		Samples	Samples			
1*	-1.71	122	35		0.02	8.38 0.18

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2	-1.08	314	188	0.09	5.01	0.34
3	-0.75	102	66	0.12	5.10	0.47
4	0.27	47	23	0.07	10.92	1.31

GSD of the Arithmetic Means 2.29

** In his presentation at the 1999 AIChE "Exposure Estimation From Left-Censored Exposure Distributions" N. Esmen reported that the graphical method provided reasonable estimates when at least 30% of samples were detected. For the first worker $35/122 = 29\%$ are detected.*

Again, within worker variability is very large. The distance between the geometric and arithmetic means points to the large contribution of excursions to the overall risk of the group. For worker 2, one measurement, $13.6 \mu\text{g}/\text{m}^3$, accounted for more than a 12% of his or her mean exposure level. This underlying distribution of high day-to-day variability and low predictability in exposures indicates a need for frequent monitoring to provide workers and their supervisors with information on work practices that cause exposure.

A third example shows that frequent exposure monitoring can lead to an exceptional level of exposure control despite high variability. This data set is made-up of 7672 personal breathing zone measurements collected over a 2 year period from a crew cleaning beryllium contaminated facilities and equipment at the Rocky Flats Environmental Technology Site. There was no operating process equipment contributing to exposure. The industrial hygienists recognized that work practices would be the primary exposure determinants. They established a 100% monitoring strategy and made sample analysis results available the next day. In this way they provided the information needed to understand the causes of exposures and helped develop a very high level of skill in this crew.

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Like the Y-12 data, this distribution is left censored. All work shifts were monitored but over 70% (5560/7672) were non-detected. With the exception of the 95th %, which was directly measured, distribution parameters are difficult to estimate with any confidence. The exposure potential is not trivial as evidenced by a few very high results. The arithmetic mean of this distribution is probably about 0.031 $\mu\text{g}/\text{m}^3$. Substituting zero for non-detected results produced a mean of 0.0306 $\mu\text{g}/\text{m}^3$ while substituting the detection limit for non-detected results produced a mean of 0.0313 $\mu\text{g}/\text{m}^3$. This indicates that it is likely that the mean is larger than the 95th %, which again points to risk being determined by a few very high exposures. In this situation, frequent monitoring is the only feasible method of detecting the exposures that create risk so that their causes can be determined and steps taken to reduce risk.

Range of 8-Hr TWAs

<u>Rank</u>	<u>Result</u>
1	< 0.001 $\mu\text{g}/\text{m}^3$ (Minimum)
...	
3837	< 0.001 $\mu\text{g}/\text{m}^3$ (Median)
...	
5561	0.001 $\mu\text{g}/\text{m}^3$ (First Detectable Result)
7290	0.02 $\mu\text{g}/\text{m}^3$ (95 th %)
...	
7671	11.27 $\mu\text{g}/\text{m}^3$
7672	12.92 $\mu\text{g}/\text{m}^3$
7673	57 $\mu\text{g}/\text{m}^3$ (Maximum)

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Appendix C

BERYLLIUM-ASSOCIATED WORKER REGISTRY DATA COLLECTION AND MANAGEMENT GUIDANCE

The Beryllium-Associated Worker Registry is a Department of Energy (DOE) complex-wide database of beryllium-associated workers. The registry is used to understand the extent of beryllium sensitization and disease throughout the DOE complex, the characteristics of previous exposures, the associated risks of developing beryllium-related conditions, and the effectiveness of current beryllium control programs. The registry contains data on current and former beryllium-associated workers and pertinent exposure and medical information. The registry includes demographics, job and exposure information, and beryllium-related health impacts such as beryllium sensitization and chronic beryllium disease (CBD). The registry does not contain identifying information such as a worker's name, address, or social security number. Each beryllium-associated worker is assigned a unique identification number which is established and maintained by the site. The registry is managed by DOE's Office of Epidemiologic Studies (EH-62); the data are maintained by the Center for Epidemiologic Research at the Oak Ridge Institute for Science and Energy.

This guidance provides an overview for submission of data to the registry for beryllium-associated workers as required by 10 CFR 850. EH-62 will provide detailed guidance on submission of these data to the registry. Reports will be published annually and shared with responsible employers and their work forces. The responsible employers should distribute copies of reports generated by the registry to their workers.

All organizations that are subject to 10 CFR 850 must submit data to the DOE beryllium registry and should submit those data in the format and timeframe specified by the registry. The registry will work

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with individual responsible employers to facilitate data collection and submission. Responsible employers should identify a point of contact who will ensure regular, complete and timely data submittal to the registry. Responsible employers that currently have an Epidemiologic Surveillance Program (EPS) data coordinator may use the coordinator as the registry point of contact.

A unique identifier for each beryllium-associated worker must be assigned by responsible employers to link an individual worker with his/her beryllium-related records without personally identifying the worker in the registry. Every record submitted to the Data Center must include this identification number. Responsible employers that have previously enrolled in the EPS should use the existing EPS identifiers as the identification number. Unique identifiers should not be overly simplistic (such as reversing the worker's social security number) and should not duplicate existing unique identifiers. Responsible employers should not reassign a unique identifier to a different worker if a worker with a beryllium registry unique identifier leaves employment, and should restore the original unique identifier to returning workers. Responsible employers should obtain any previously used unique identifiers assigned to a worker by other responsible employers and notify the Data Center of the existence of two unique identifiers for a single individual to ensure continuity of information on the workers. Only the SOMD, or other appropriately designated site personnel, will have the ability to identify individual workers from their unique identifiers.

Data must be submitted to the Data Center semi-annually. The reporting periods begin on January 1 and July 1. Responsible employers should submit data electronically no later than January 15 and July 15 to:

DOE Beryllium Registry
ORISE Center for Epidemiologic Research
Medical Sciences Division

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(423) 576-3142

Data to be submitted will be grouped into four files.

- C Roster of Beryllium-Associated Workers;
- C DOE Beryllium Job and Exposure data;
- C Beryllium-related Medical Surveillance; and
- C Mortality of Beryllium-Associated Workers.

Roster of Beryllium-Associated Workers. This file must include all workers who are defined as beryllium-associated workers by 10 CFR 850. Information in this file includes a unique identifier for each individual; date of birth; gender; employer type such as federal, contractor, or other; and date of separation from employment.

DOE Beryllium Activities and Exposure Surveillance. This file contains information concerning all DOE beryllium activities in which the worker currently works or previously has worked and the exposures resulting from those activities. The responsible employer should include information on working directly with beryllium, working in areas of potential beryllium exposure even if not working directly with beryllium, and activities with potential casual exposure to beryllium such as working near an area where others are working directly with beryllium. Information in this file includes buildings and rooms where exposed or potentially exposed; organizational codes; job title; dates of beryllium activity; the type of beryllium activity such as production, maintenance, etc.; use of personal protective equipment; level of exposure; method of measuring exposure; units of measure; sampling time; and number of hours of exposure.

Beryllium-Related Medical Surveillance. This file contains the medical information obtained by the SOMD related to past or current beryllium exposures and medical evaluations. Information in this file

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includes who referred the employee for beryllium medical surveillance; whether currently in beryllium-related medical surveillance; any former beryllium-related medical surveillance; former employers (only beryllium exposure-related); participation in a former workers' study; dates and results of Be-LPTs, flow cytometry, lung lavage, lung biopsy, chest x-rays, pulmonary function tests; symptoms; diagnoses; and case dispositions.

Mortality of Beryllium-Associated Workers. This file contains cause-of-death information for workers included in the registry. Cause-of-death information should be abstracted from the death certificate when available. If cause-of-death information is available from the medical record without the supporting death certificate, the information on causes of death should be submitted and noted accordingly. Information in this file includes: date of death, immediate cause of death, and all contributing causes of death.

The Beryllium Registry is managed by:

U.S. Department of Energy
Office of Epidemiologic Studies, EH-62
(301) 903-9826